# AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES: CASE STUDIES

**INSTITUTE OF TRANSPORTATION ENGINEERS WEBINAR PART 2 – MAY 7, 2014**

# ITE Webinar Series on Automated Traffic Signal Performance Measures (SPMs)

- Achieve Your Agency's Objectives Using SPMs

  April 9, 2014, 12:00 pm to 1:30 pm. Eastern

- SPM Case Studies

  May 7, 2014, 12:00 pm to 1:30 pm. Eastern

- Critical Infrastructure Elements for SPMs

  June 11, 2014, 12:00 pm to 1:30 pm. Eastern

# Automated Traffic Signal Performance Measures

## Technology Implementation Group: 2013 Focus Technology

**http://tig.transportation.org**

Mission: Investing time and money to accelerate technology adoption by agencies nationwide

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS
AASHTO
THE VOICE OF TRANSPORTATION

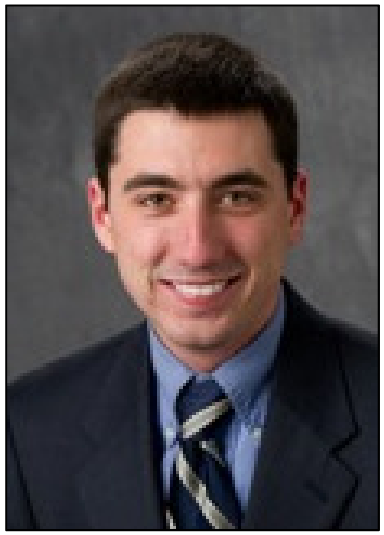
DRIVING INNOVATION FOR TRANSPORTATION
TIG
AASHTO TECHNOLOGY IMPLEMENTATION GROUP

# Your Speakers Today

Jamie Mackey, UDOT

Amanda Stevens, INDOT

Alex Hainen, Purdue



Steve Misgen, MnDOT

Rick Denney, FHWA

Moderator

# AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES CASE STUDIES: UDOT

**INSTITUTE OF TRANSPORTATION ENGINEERS WEBINAR PART 1 – MAY 7, 2014**

PRESENTED BY JAMIE MACKEY, UDOT

# Automated Signal Performance Measures Goals

- Operate & optimize system without field data collection
- Catch problems as they happen
- Retime signals as needed, not on a schedule
- Communicate signal/corridor/system performance to public & agency leaders

# Signal Performance Metrics

An AASHTO TIG-sponsored Technology

Charts | Reports | Log Action Taken | Links | FAQ

->Signal Metrics

Selected Signal

No Signal Selected

Signals

Region: All

Metric Type: All

Filter: Signal Id | Filter | Clear Filter

Signal List

Map


Metric Settings

Metric Type

- Approach Delay
- Approach Volume
- Arrivals On Red
- Purdue Coordination Diagram
- Purdue Phase Termination
- Speed
- Split Monitor
- Turning Movement Counts

Time Y Axis Maximum: 150

Volume Y Axis Maximum: 2000

Volume Bin Size: 15

Dot Size: Small

- [x] Show Plan Statistics
- [x] Show Volumes

Export Data

- [ ] Upload Current Data

Dates

Start Date: 1/13/2014 ... 12:00 AM

End Date: 1/13/2014 ... 11:59 PM

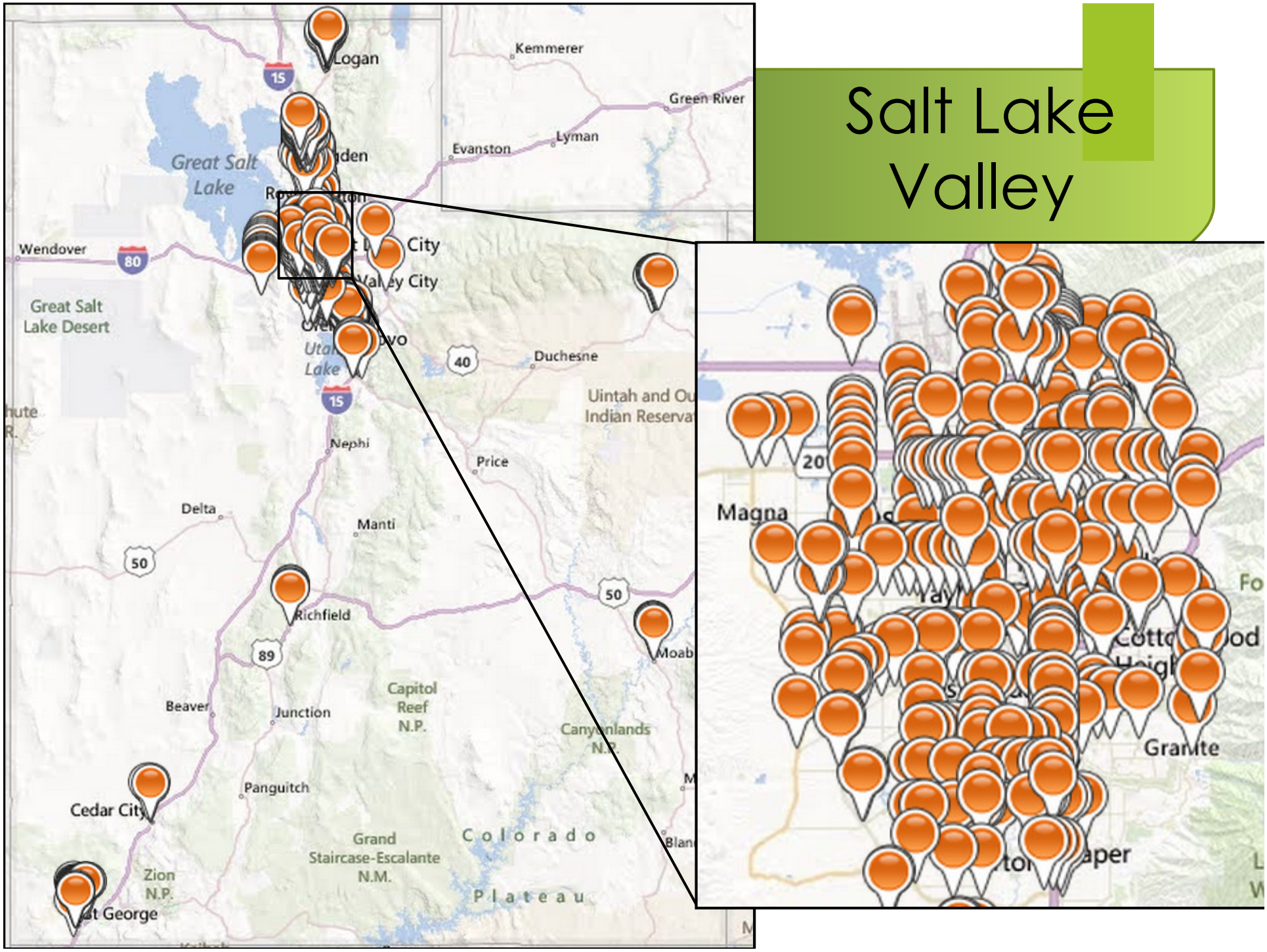
Reset Date

< January 2014 >

| Sun | Mon | Tue | Wed | Thu | Fri | Sat |
|---|---|---|---|---|---|---|
| 29 | 30 | 31 | 1 | 2 | 3 | 4 |
| 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| 19 | 20 | 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 | 31 | 1 |
| 2 | 3 | 4 | 5 | 6 | 7 | 8 |

**http://udottraffic.utah.gov/signalperformancemetrics**

# Salt Lake Valley



# Metrics & Detection Requirements

| Controller high-resolution data only |
| --- |
| Purdue Phase Termination |
| Split Monitor |

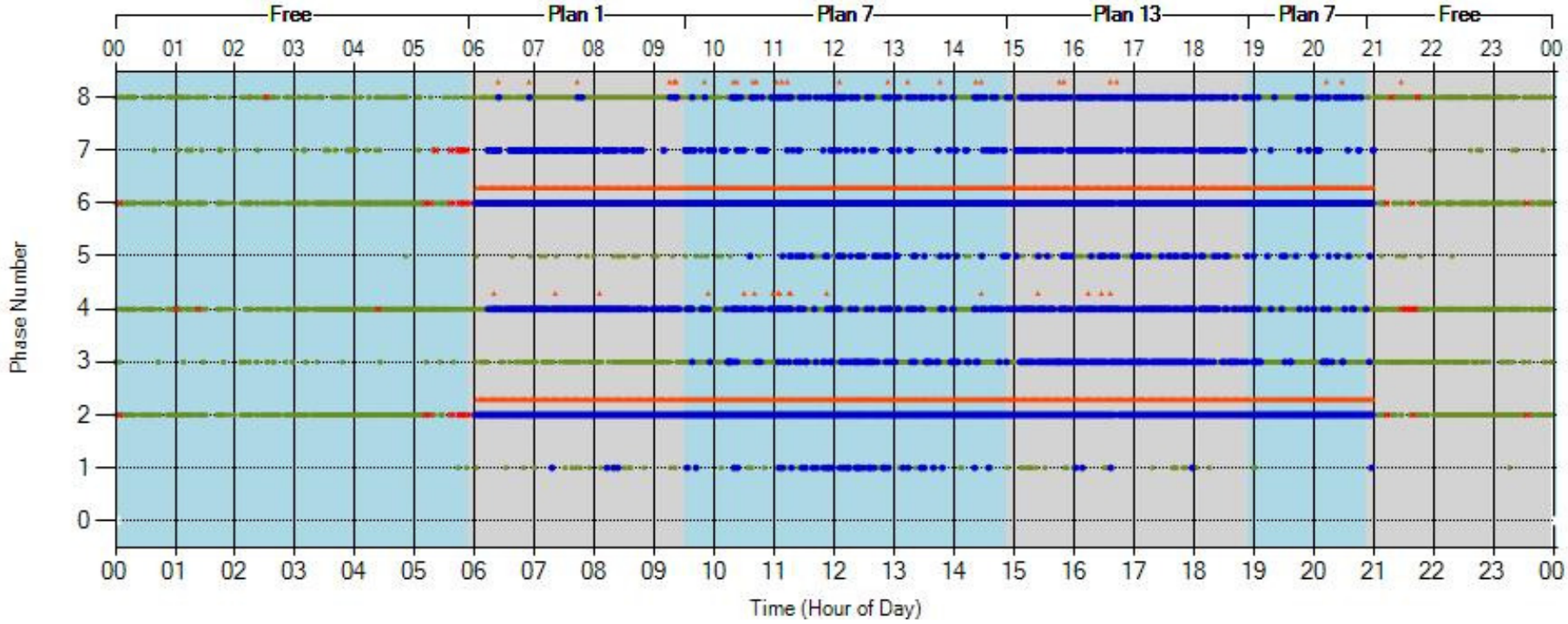
| Advanced Count Detection (~400 ft behind stop bar) |
| --- |
| Purdue Coordination Diagram & Arrivals on Red |
| Approach Volume |
| Approach Delay |
| Executive Summary Reports |

| Advanced Detection with Speed | Lane-by-lane Presence Detection |
| --- | --- |
| Approach Speed | Split Failure (future) |

| Lane-by-lane Count Detection | Probe Travel Time Data (GPS or Bluetooth) |
| --- | --- |
| Turning Movement Counts | Purdue Travel Time Diagram |

# Normal Intersection Example: Phase Termination Chart

- 24-hours of phase data at an 8-phase signal with working detection

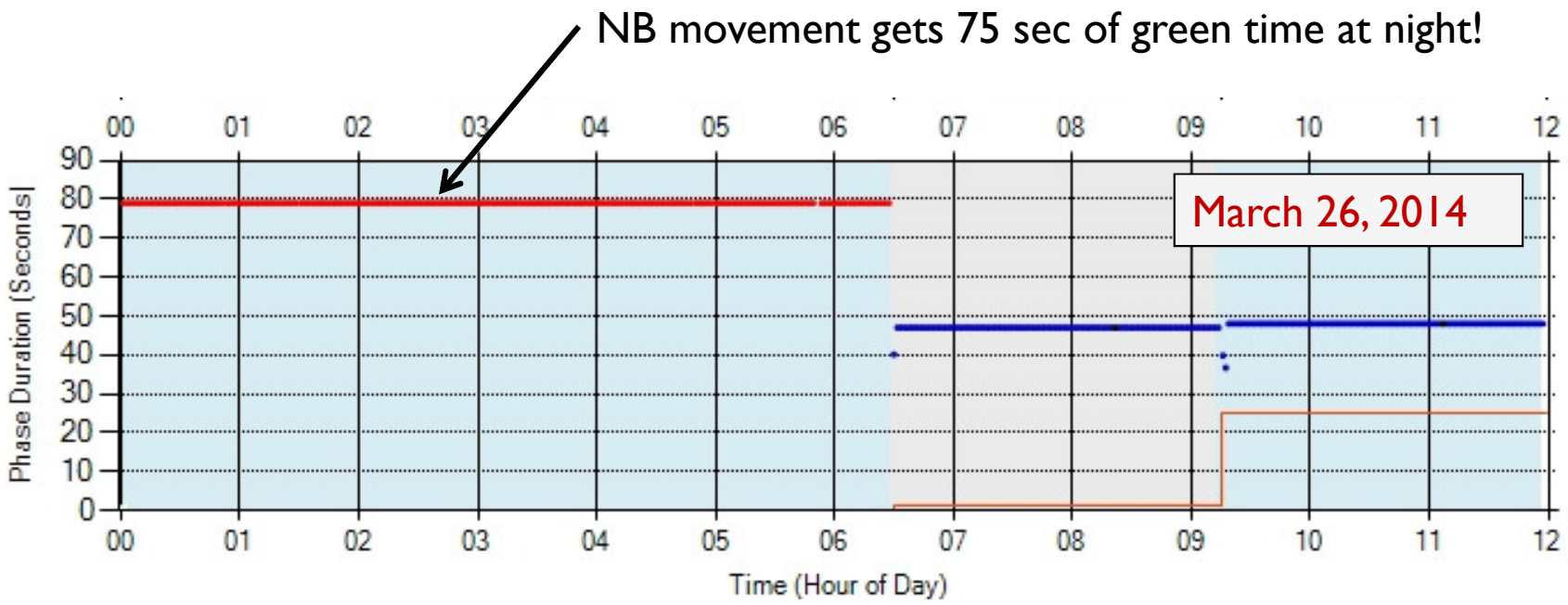



- Gapout
- Max out
- Force off
- Pedestrian activation (shown above phase line)
- Skip

**Metric: Split Monitor**
**Detection Requirements: None**

# Complaint Example: Red light too long

- Max recall was placed for broken NB detection

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**Metric: Split Monitor**
**Detection Requirements: None**

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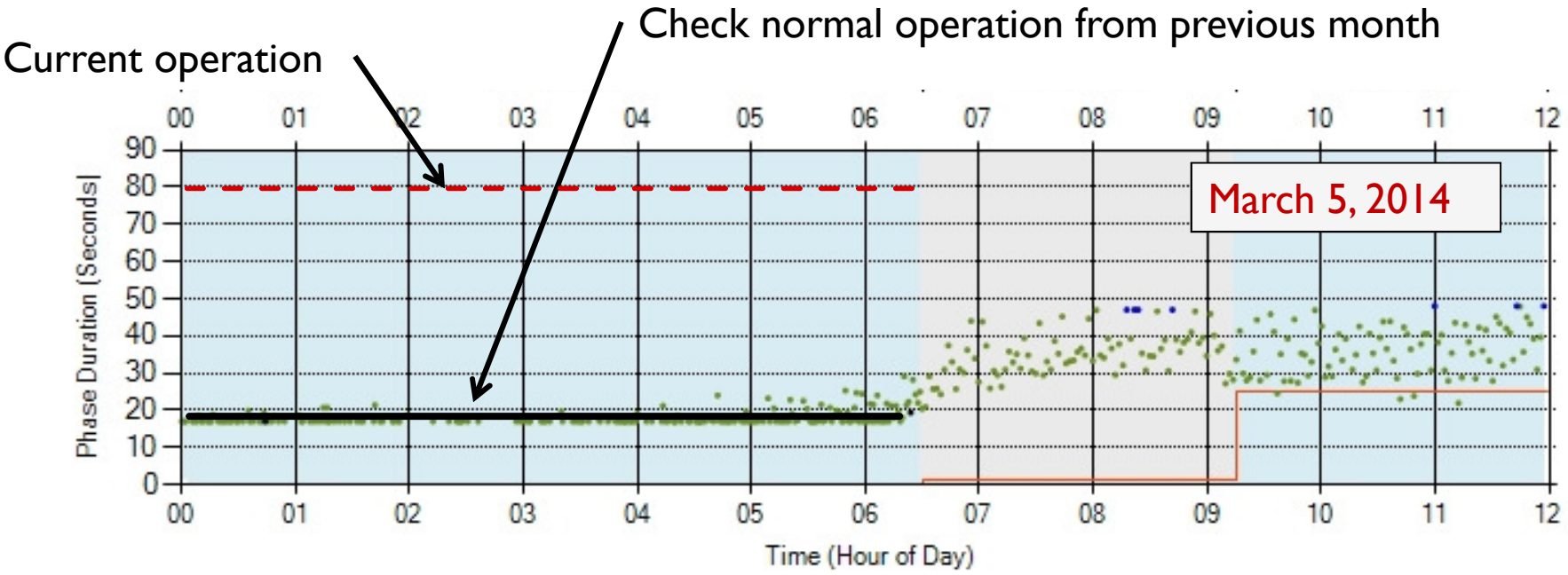


Gapout

Max out

Force off

Pedestrian activation (shown above phase line)

Skip

**Metric: Split Monitor**
**Detection Requirements: None**

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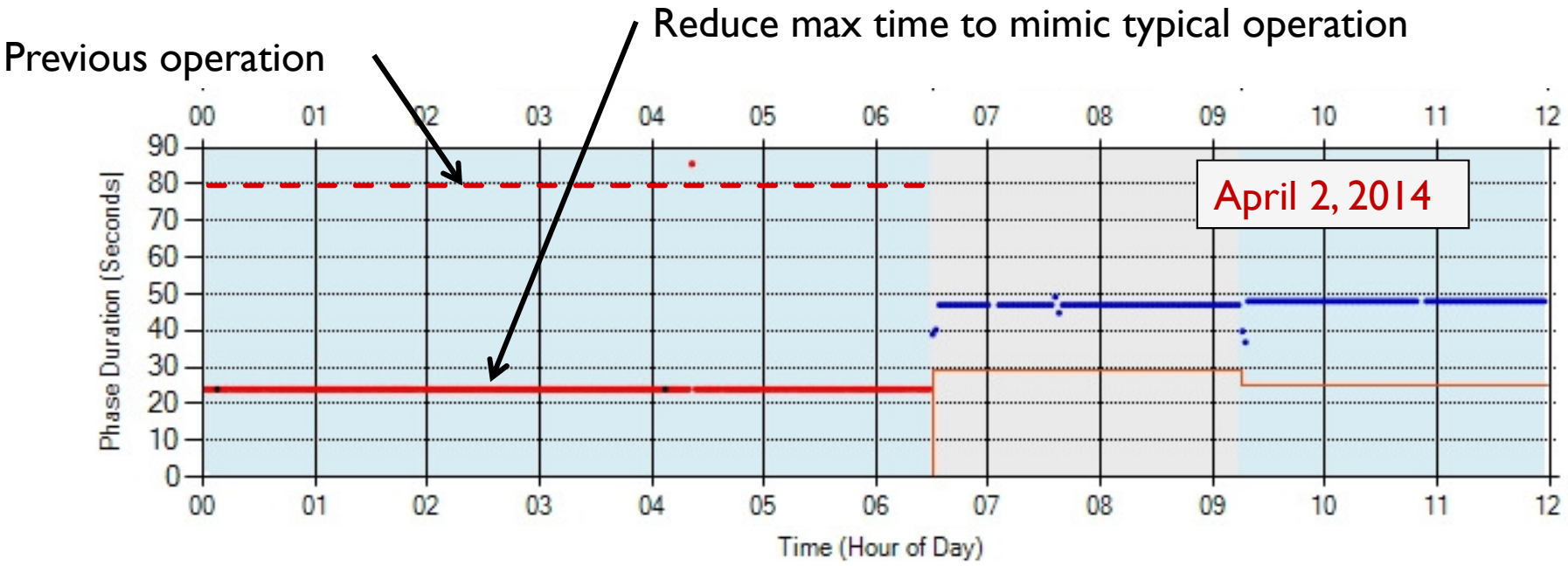



Gapout

Max out

Force off

Pedestrian activation (shown above phase line)

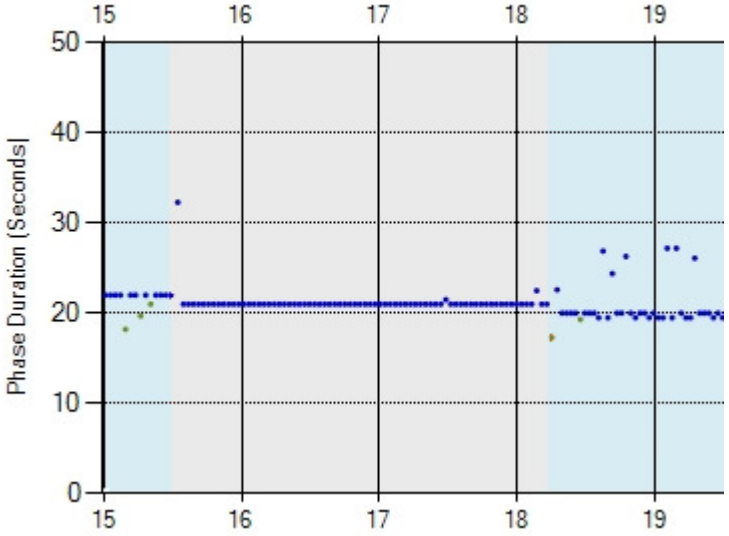
Skip

**Metric: Split Monitor**
**Detection Requirements: None**

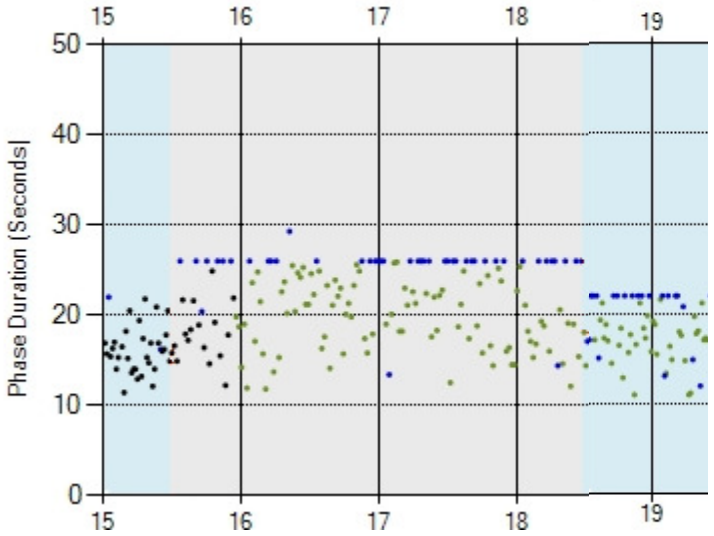
# Complaint Example: Split too short

- Is this a timing or a maintenance issue?

Timing Issue:
Phase always forces off
=> Phase is using all programmed time




Maintenance Issue:
Phase often gaps out
=> Spotty right-turn lane detection

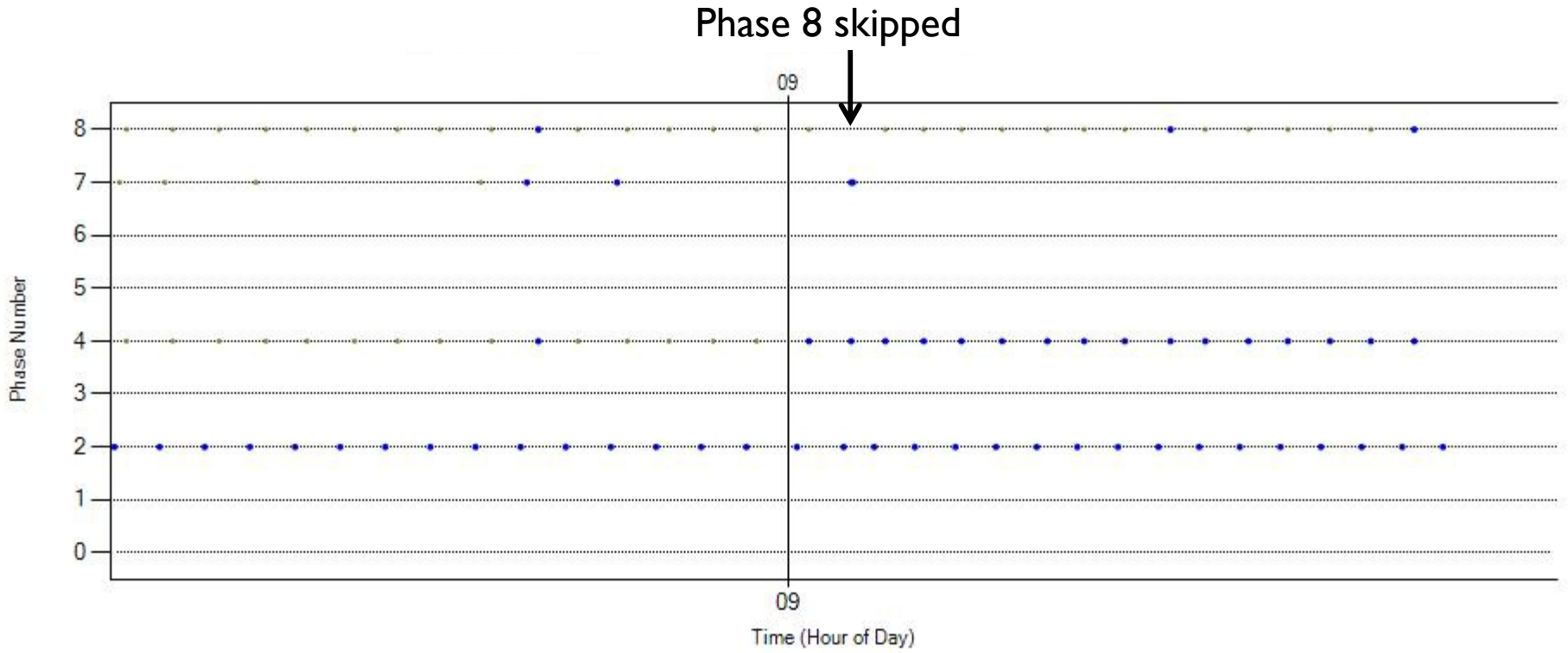



- Gapout
- Max out
- Force off
- Pedestrian activation (shown above phase line)
- Skip

**Metric: Split Monitor**
**Detection Requirements: None**

# Complaint Example: Phase skipped

- SPMs confirm it was a fluke




Gapout

Pedestrian activation (shown above phase line)

Max out

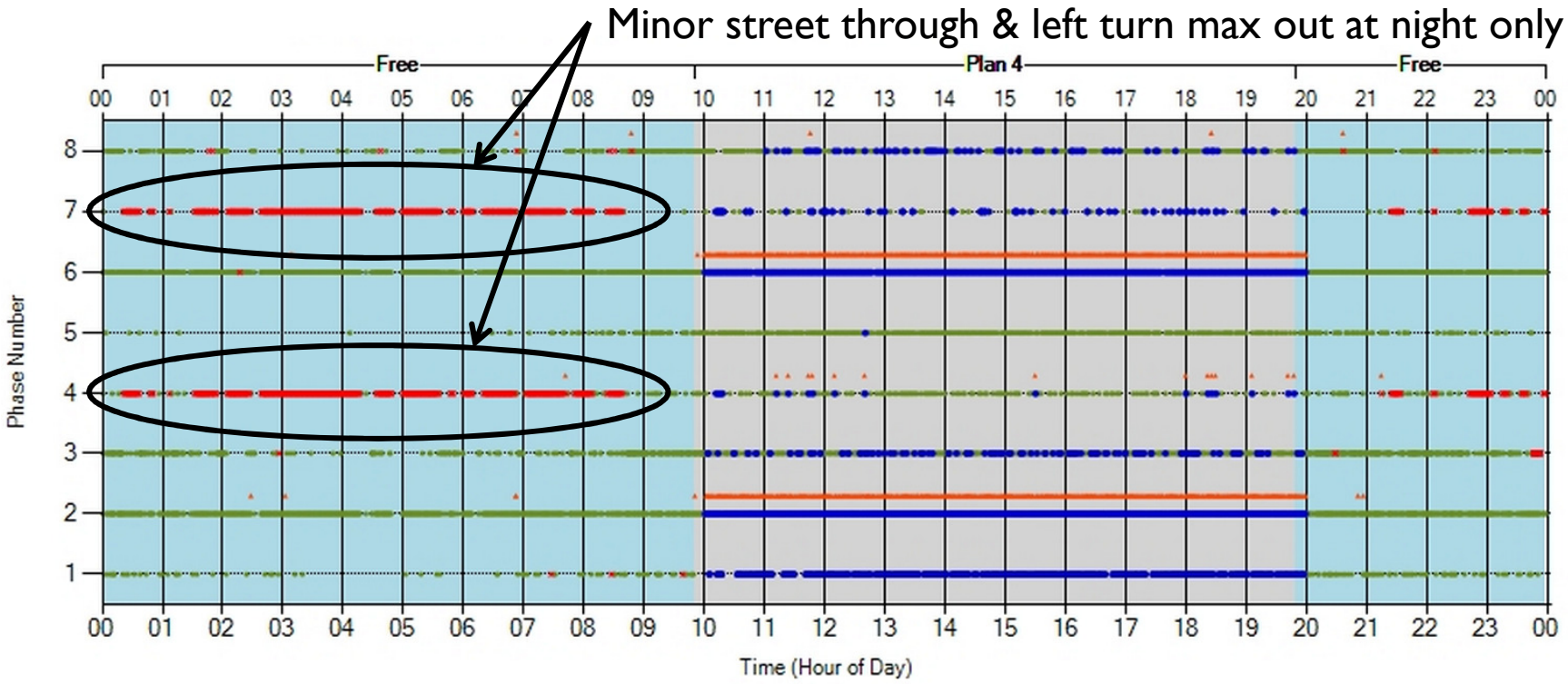
Skip

Force off

**Metric: Purdue Phase Termination**
**Detection Requirements: None**

# Maintenance Example: Nighttime detection problem

- BEFORE: Video detection not working at night




Gapout

Pedestrian activation (shown above phase line)

Max out

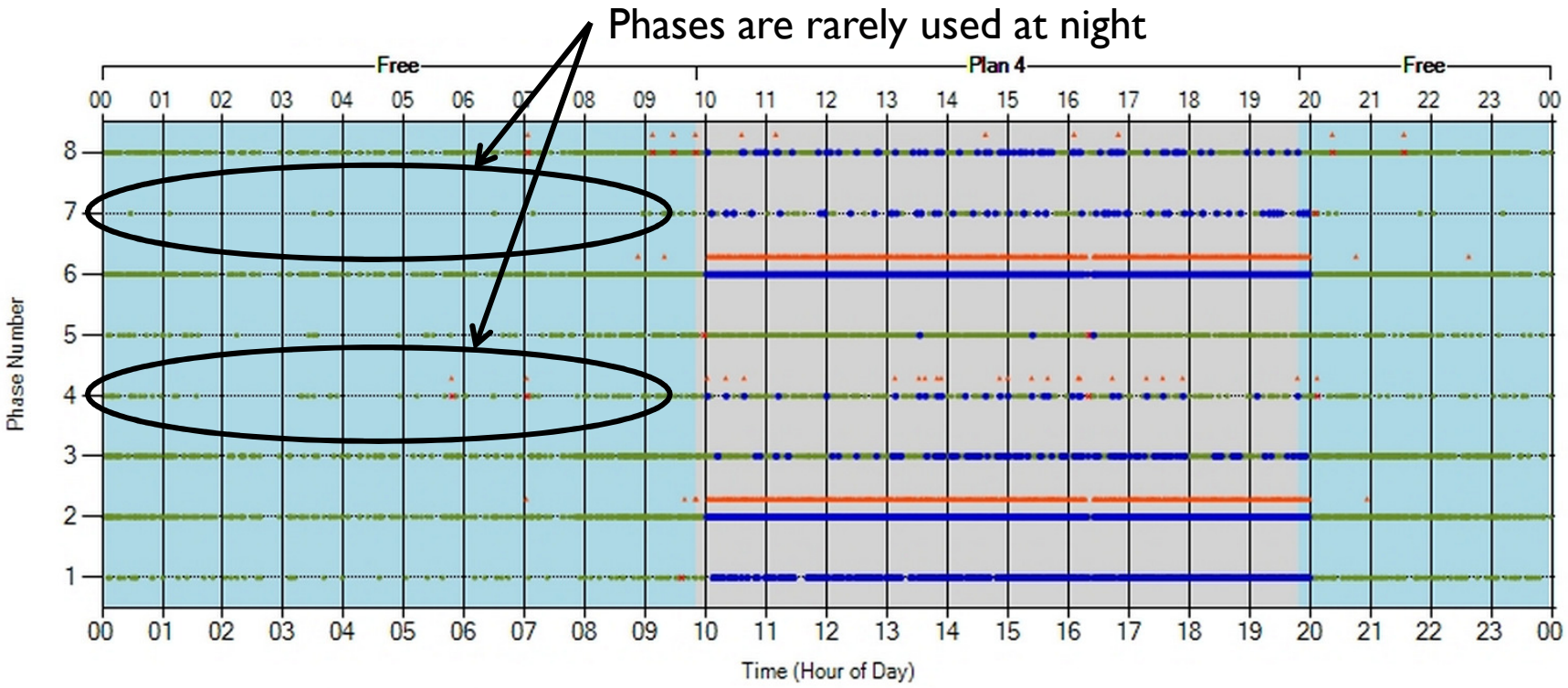
Skip

Force off

**Metric: Purdue Phase Termination**
**Detection Requirements: None**

# Maintenance Example: Nighttime detection problem

- AFTER: New detection technology installed




Gapout

Pedestrian activation (shown above phase line)

Max out

Skip

Force off

**Metric: Purdue Phase Termination**
**Detection Requirements: None**

# Maintenance Example: Check for additional problems

- Phase 2 ped problem was not noticed at field visit


Gapout

Pedestrian activation (shown above phase line)

Max out

Skip

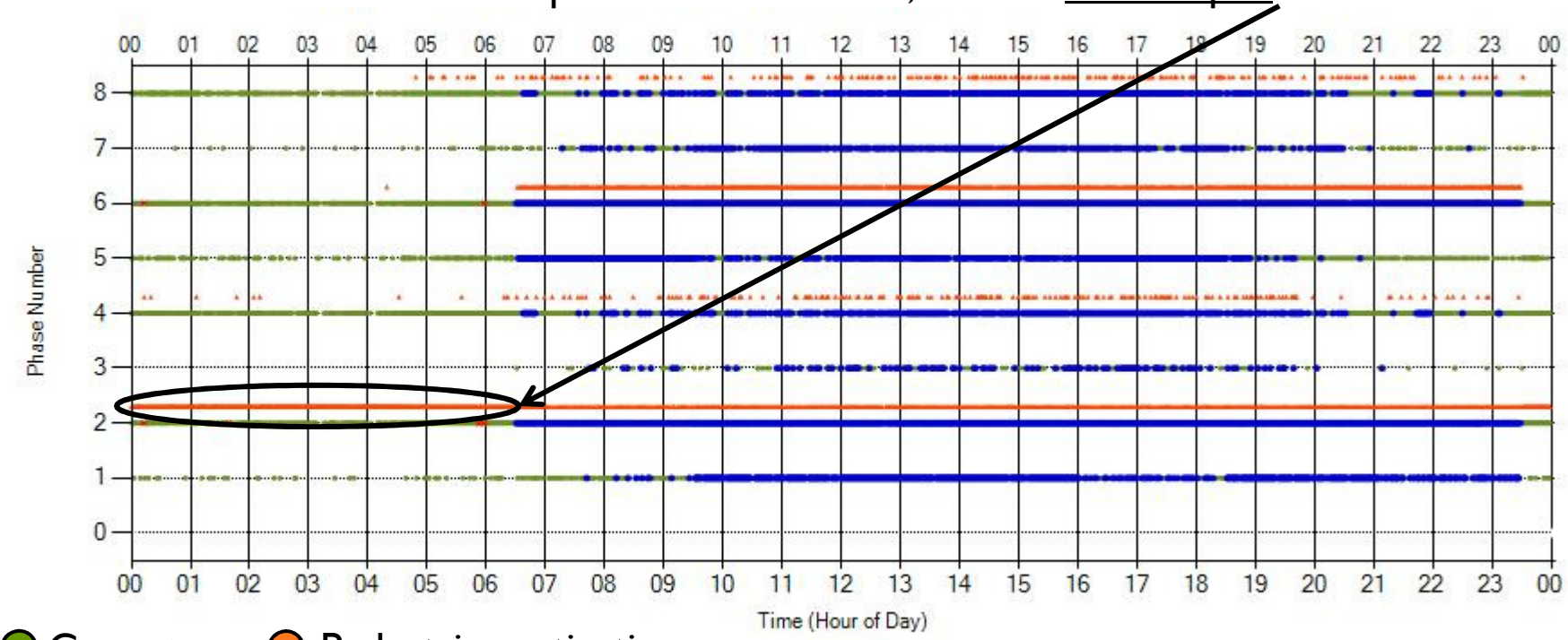
Force off

**Metric: Purdue Phase Termination**
**Detection Requirements: None**

# Maintenance Example: Check for additional problems

- Phase 2 ped problem was not noticed at field visit

10/21/2013: Phase 3 & 8 problems were fixed, but not Phase 2 ped

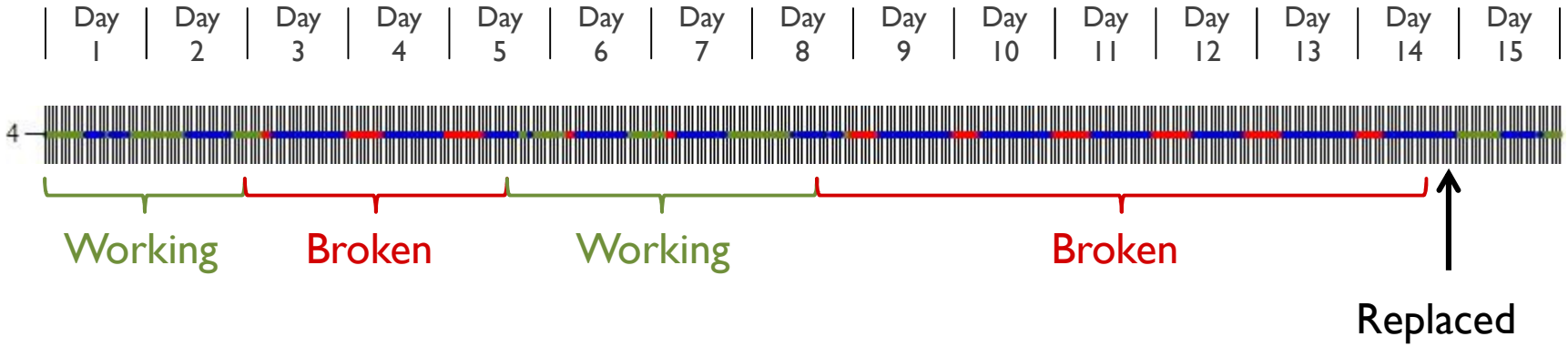



- Gapout
- Pedestrian activation (shown above phase line)
- Max out
- Skip
- Force off

**Metric: Purdue Phase Termination**
**Detection Requirements: None**

# Detection Upgrade Justification

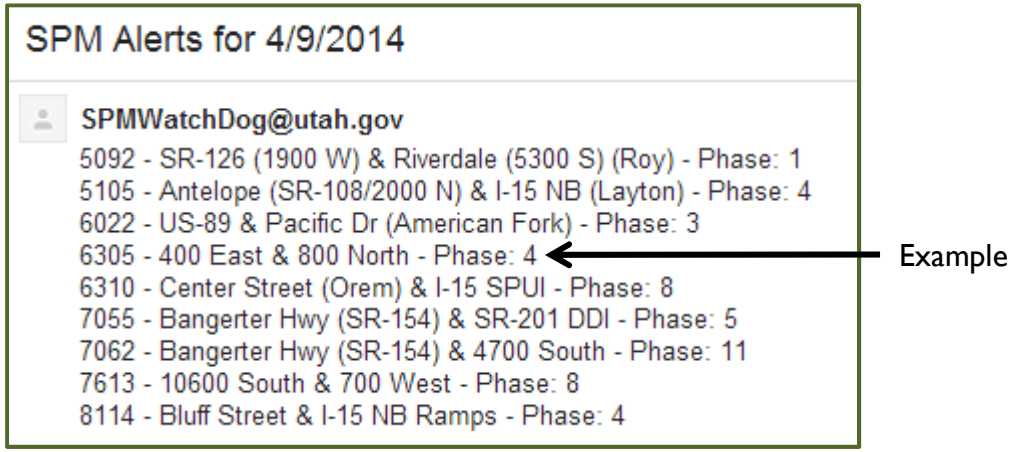
- Document recurring detection problems




- Gapout
- Max out
- Force off
- Pedestrian activation (shown above phase line)
- Skip

**Metric: Purdue Phase Termination**
**Detection Requirements: None**

# Alert Example: 100% Max Out

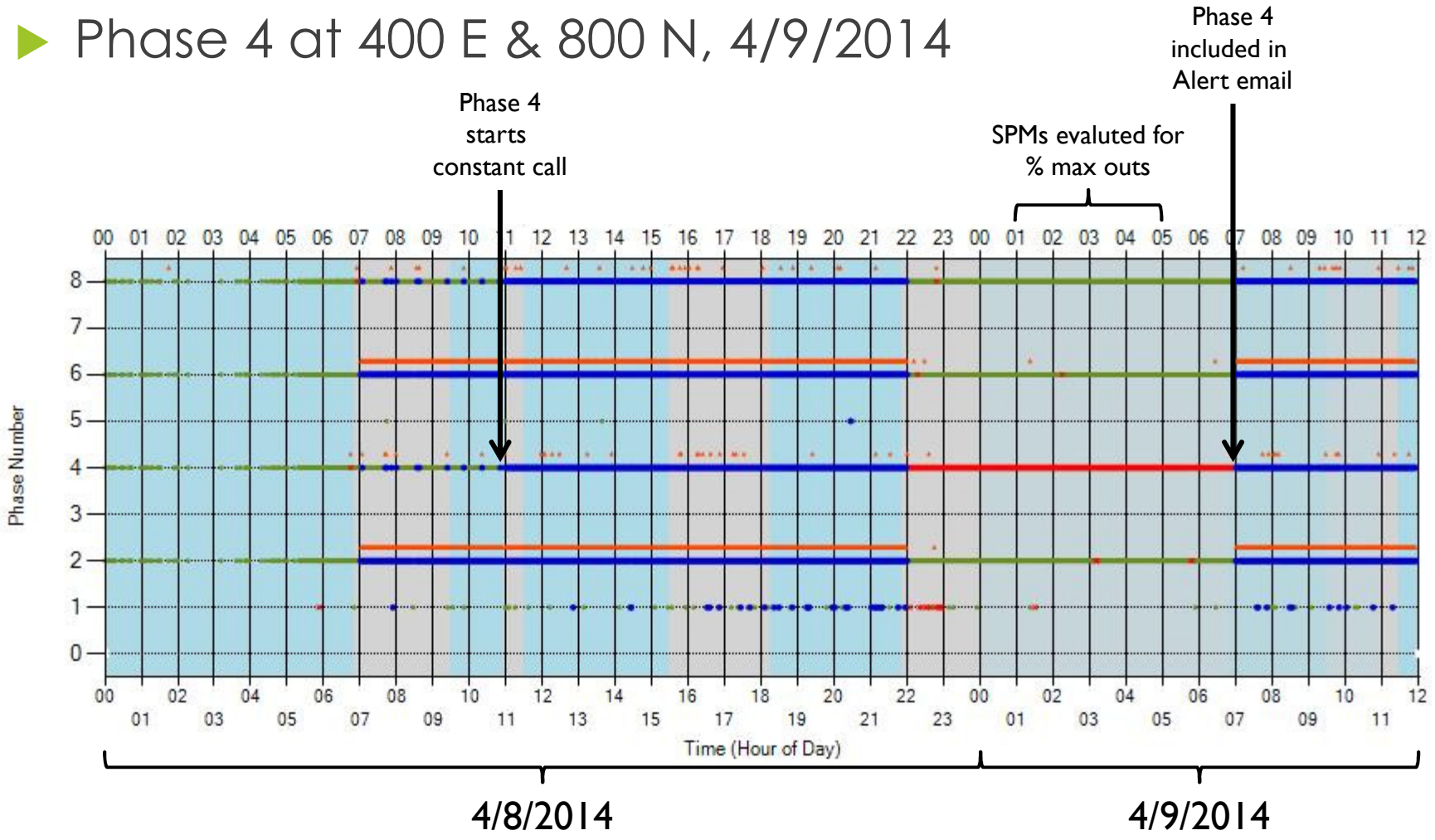



- Daily email at 7 a.m.
- Uses Purdue Phase Termination chart data
- Flags phases with >90% max-outs on each phase between 1 a.m. and 5 a.m.
- Compare to previous day's list. Only phases with new flags are sent in the email.

**Metric: Purdue Phase Termination**
**Detection Requirements: None**

# Alert Example: 100% Max Out

- Phase 4 at 400 E & 800 N, 4/9/2014




- Gapout
- Max out
- Force off
- Pedestrian activation (shown above phase line)
- Skip

**Metric: Purdue Phase Termination**
**Detection Requirements: None**

# Operations Example: Oversize Peds

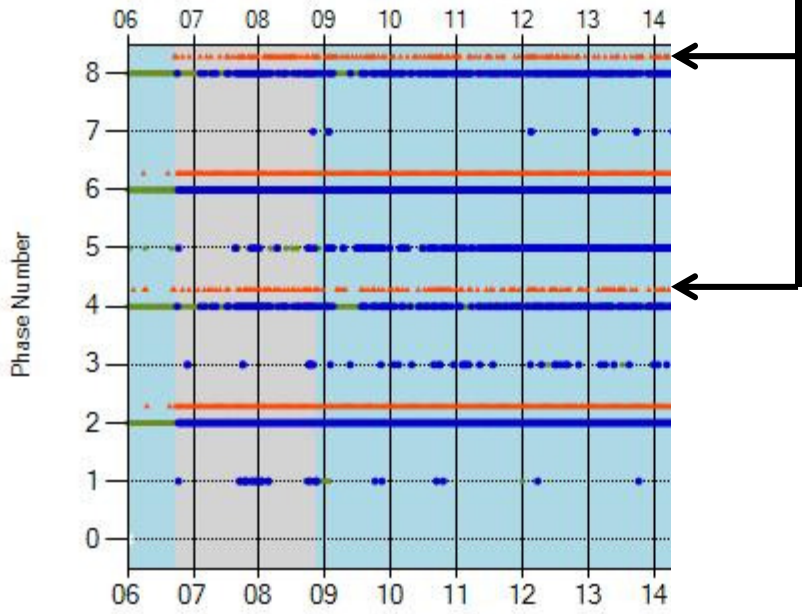
Ped buttons for Phase 4 is rarely pushed

Recommendation:
Oversize peds, if needed

- Check frequency of ped calls

Peds for Phases 4 & 8 are called **frequently**

Recommendation:
Do not oversize peds




Peds for Phases 4 & 8 are **rarely** called

Recommendation:
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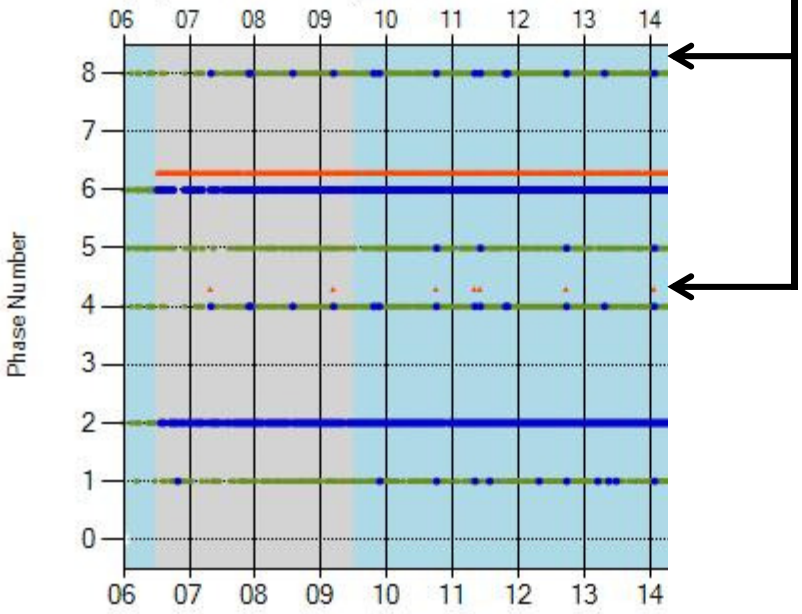



Gapout

Max out

Force off

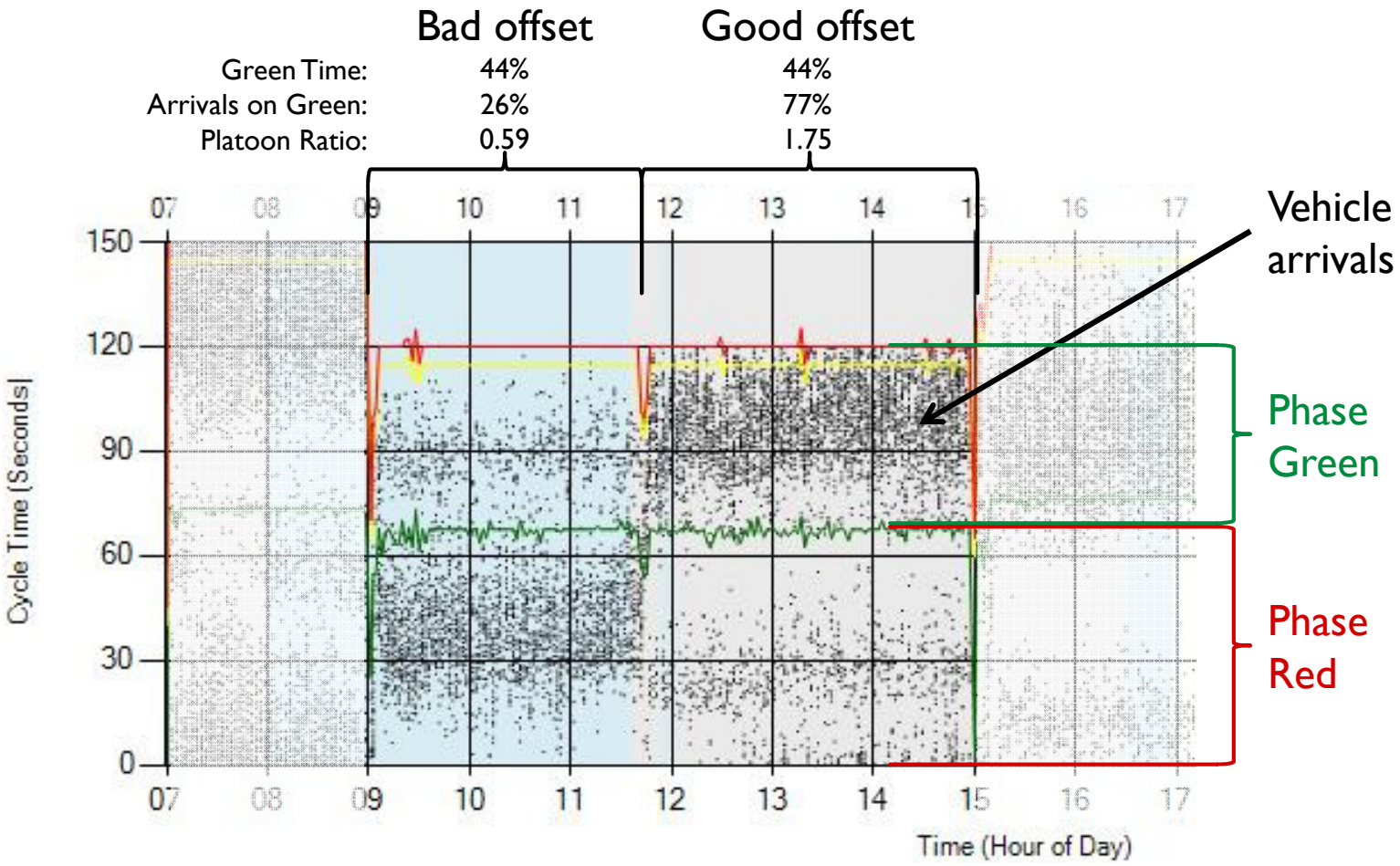
Pedestrian activation (shown above phase line)

Skip

**Metric: Purdue Phase Termination**
**Detection Requirements: None**

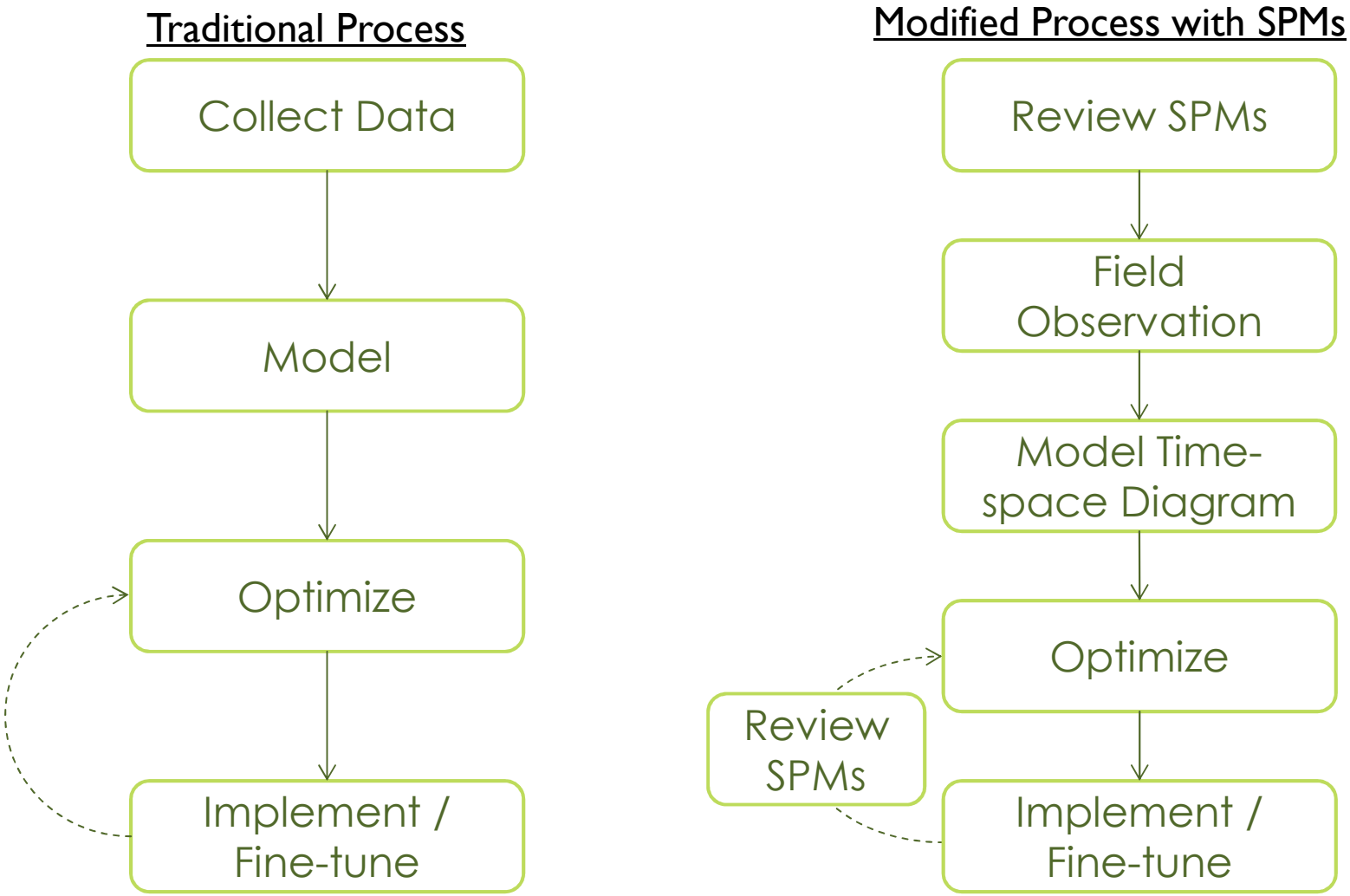
# Optimization Example: Progression Quality

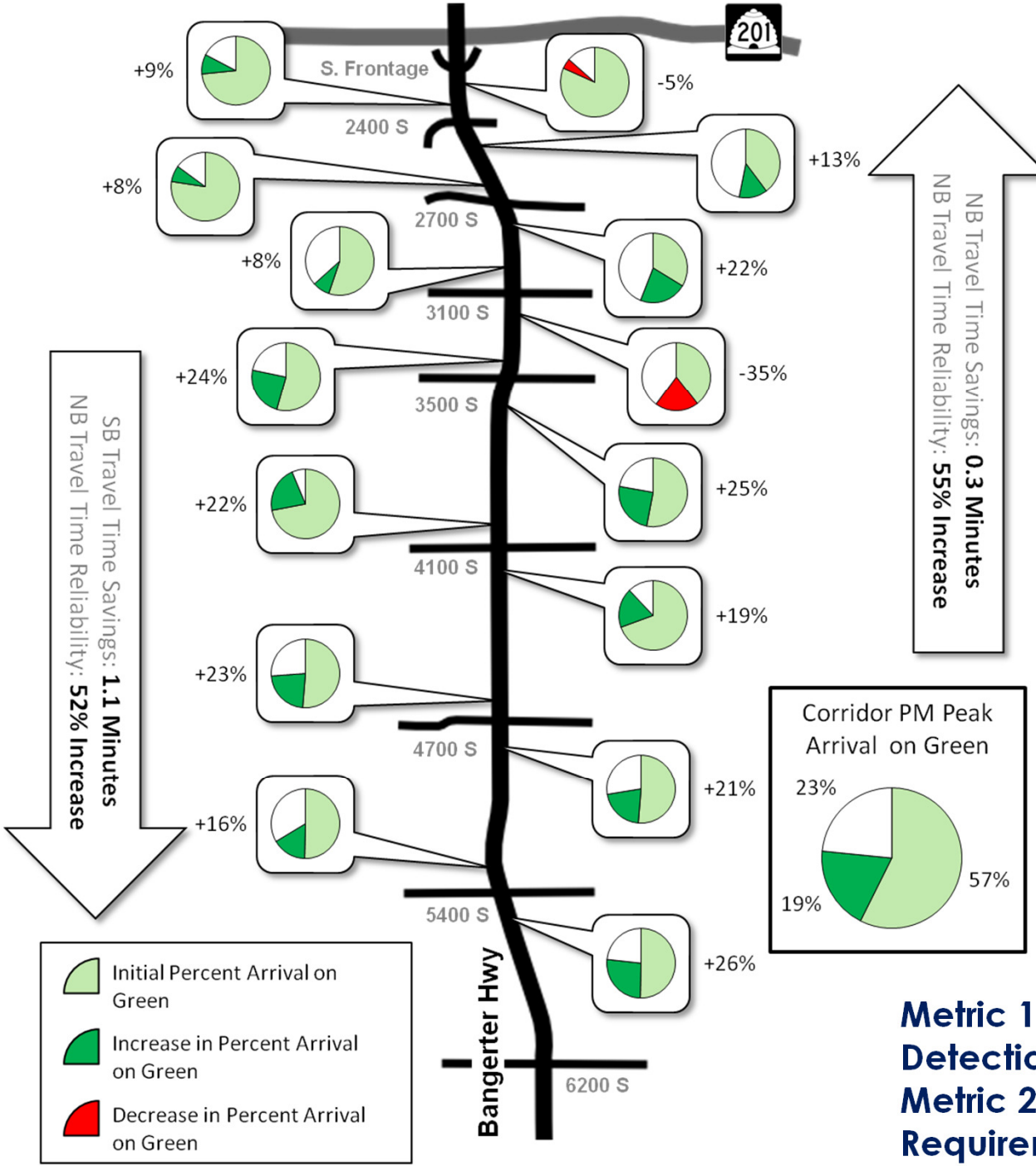
- Fine-tuning new coordination plans




**Metric: Purdue Coordination Diagram**
**Detection Requirements: Advance**

# Optimization with SPMs






## Before and After Coordination Results

Corridor: Bangerter Hwy, SLC

To/From: SR-201 - 6200 South

Date: March 2013

Time Period: PM Peak

**Results:**

- Arrivals on Green: 19% Increase

- NB TT Savings: 0.3 Minutes
- NB Reliability: 55% Increase

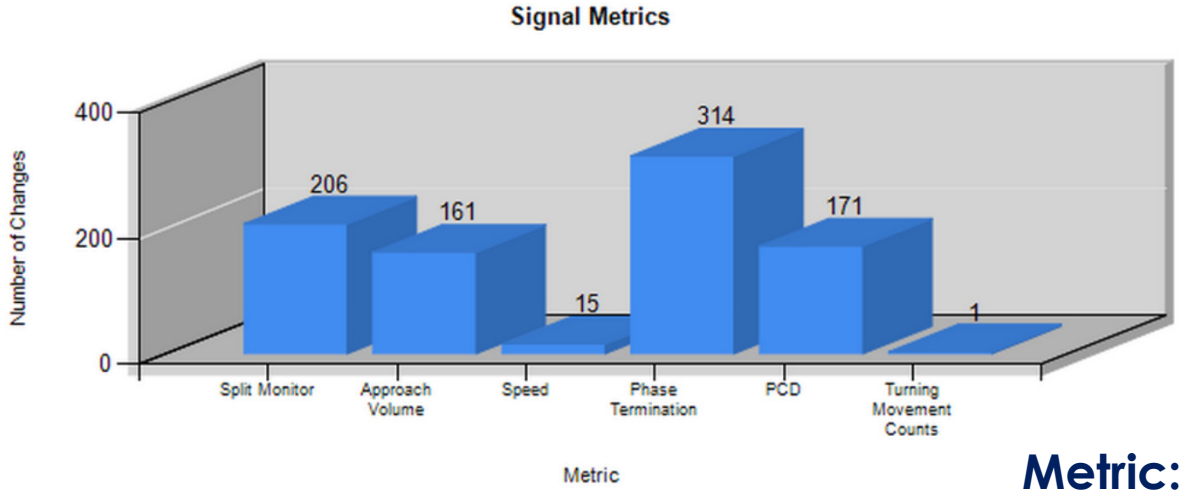
- SB TT Savings: 1.1 Minute
- SB Reliability: 52% Increase

**Metric 1: Purdue Coordination Diagram**
**Detection Requirements: Advance**
**Metric 2: Purdue Travel Time Diagram**
**Requirements: Probe data set**

# Intersection Adjustments using SPMs

## January 1, 2013 to December 31, 2013

- Adjustments made at 325+ intersections
  - 185 work orders for detector problems
  - 40 offset adjustments
  - 5 time-of-day corrections




**Metric: Usage Reports**

# System Requirements

1. Traffic signal controllers with 1/10th s. data logger
   -- Econolite (ASC/3; Cobalt)  -- Intelight ATC  -- Naztec (Beta)
   -- PEEK ATC  -- Siemens Linux / ATC
2. Communications or storage memory on controllers
3. FTP connection to signal
4. Server to store controller logs
5. Enumerations analyzed and graphed (INDOT & UDOT software developed in-house)

**Can be done independent of a Central System!**

# System Requirements

## High-resolution Controller

## Communications

1) Get ***.dat*** Files
2) Translate Files

***.dat*** ➡ ***.csv***

3) Store in Database

## Server

1) Query Database
2) Display Graphs

## Website

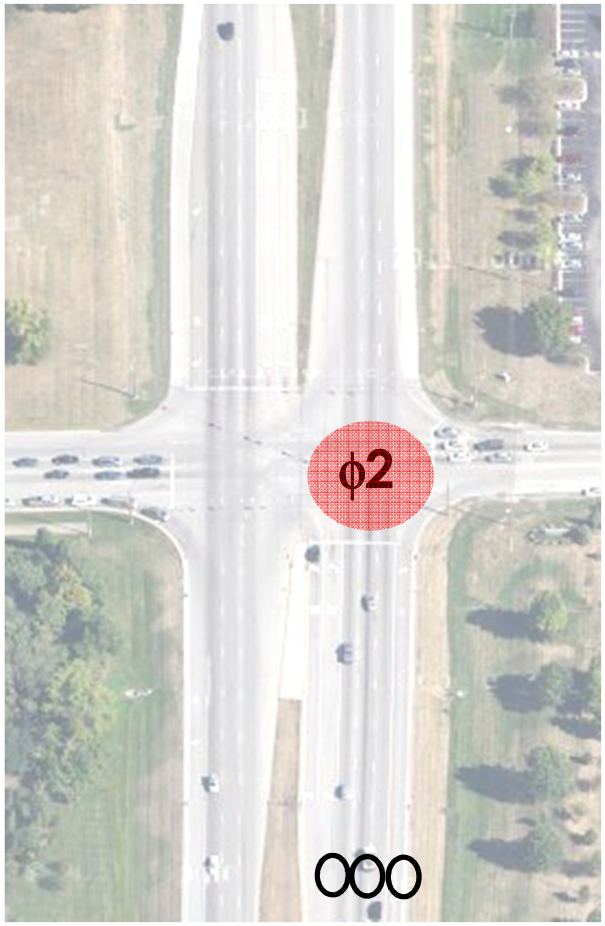
## Detection

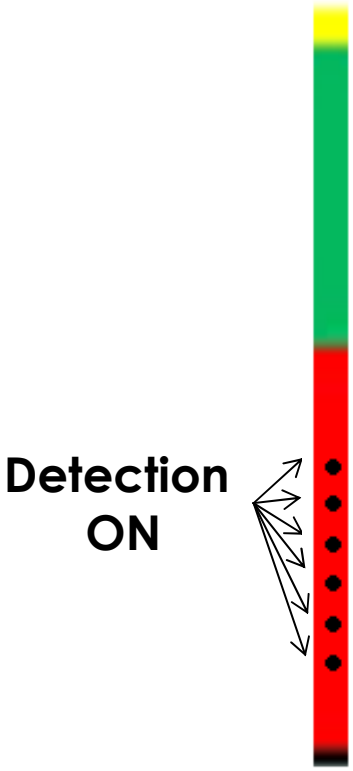
Photo courtesy of the Indiana Department of Transportation

# AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES CASE STUDIES: INDOT

**INSTITUTE OF TRANSPORTATION ENGINEERS WEBINAR PART 1 – MAY 7, 2014**

PRESENTED BY AMANDA STEVENS, INDOT AND ALEX HAINEN, PURDUE

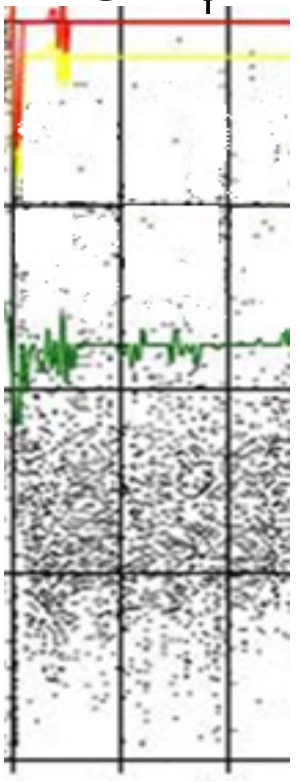



Single Instance ϕ2

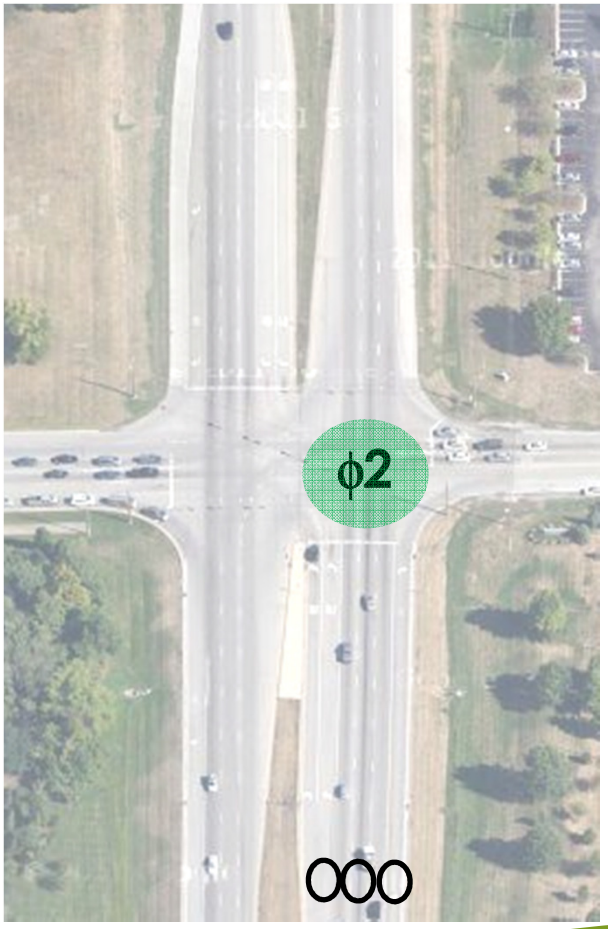
Time
in Cycle (s)

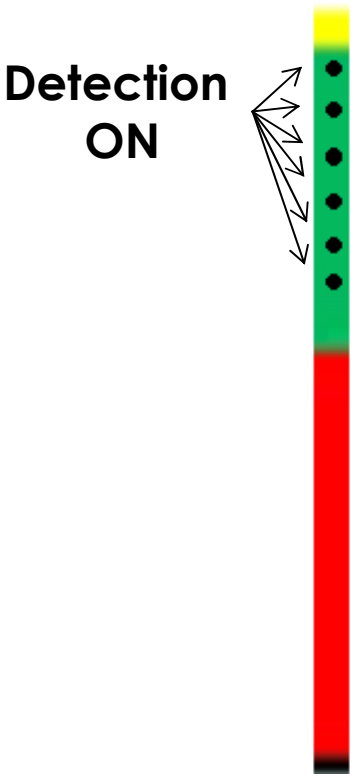
PCD ϕ2



Time of Day (hr)

# PCD: Red Arrival

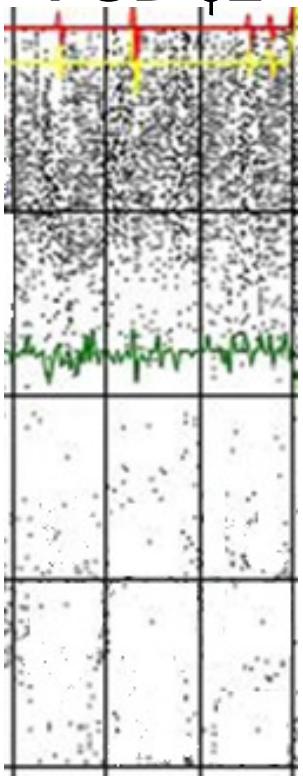



Single Instance ϕ2

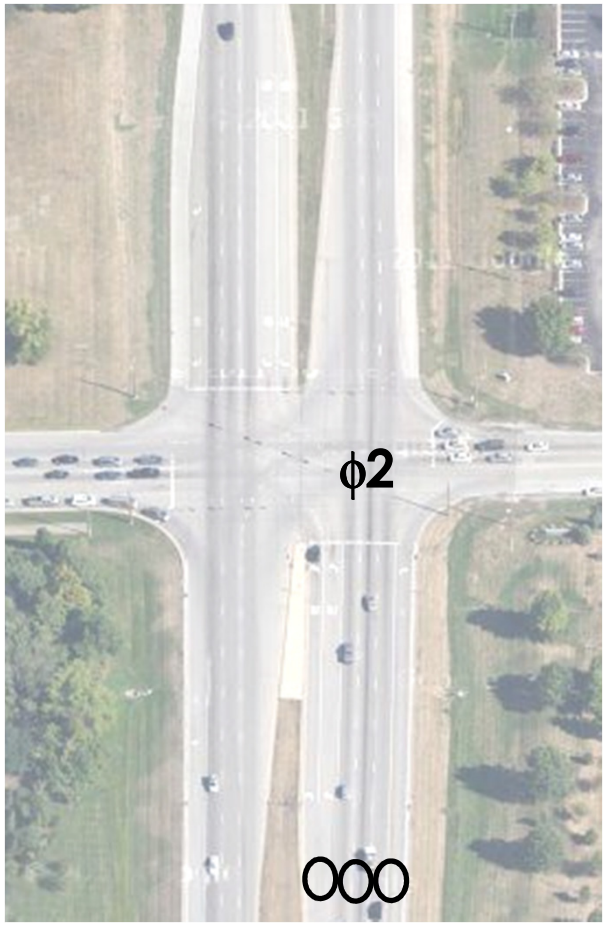
PCD ϕ2

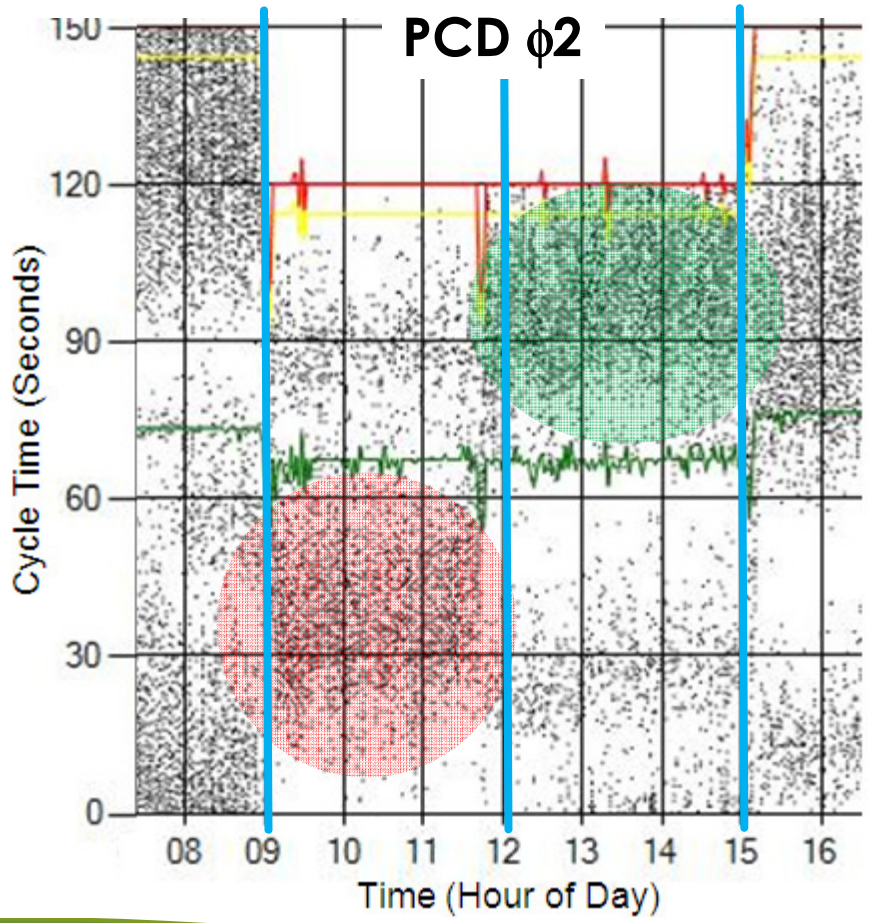
Time
in Cycle (s)



Time of Day (hr)

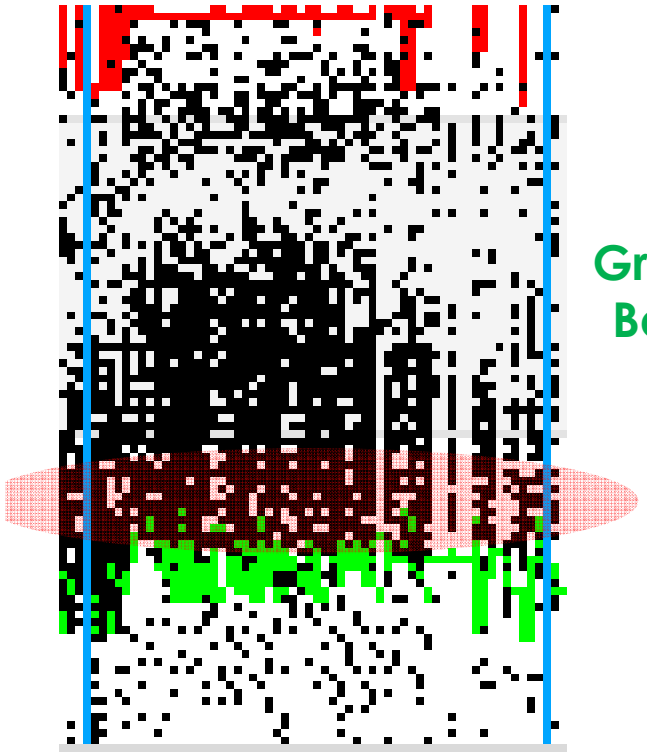
# PCD: Green Arrival



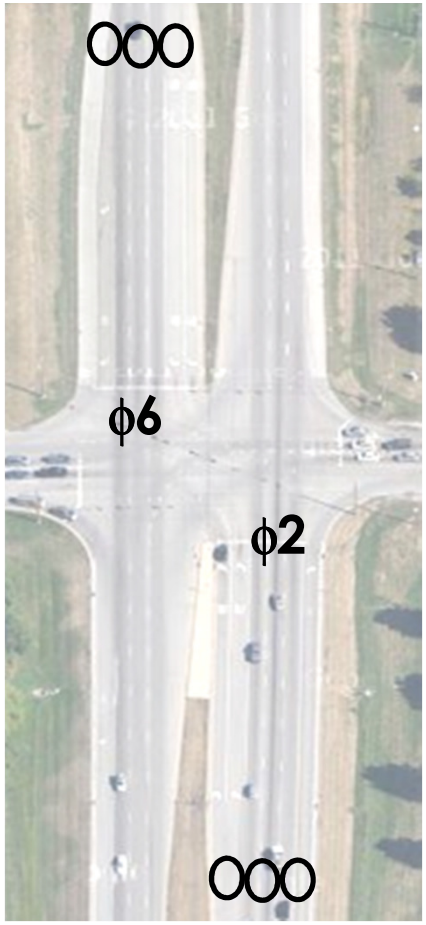




# PCD: Platoon Arrival by TOD

PCD ϕ6

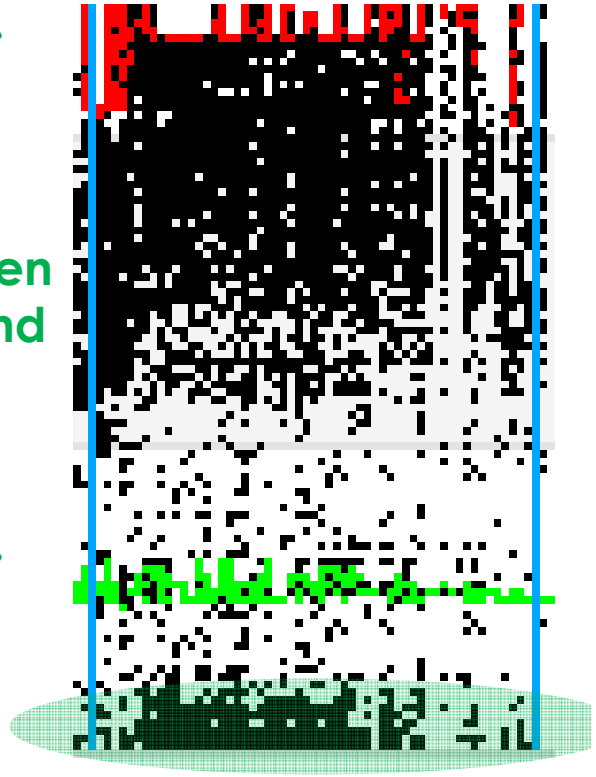


Green Band




Green Band

PCD ϕ2



# PCD: Adjust Offsets

# INDOT System

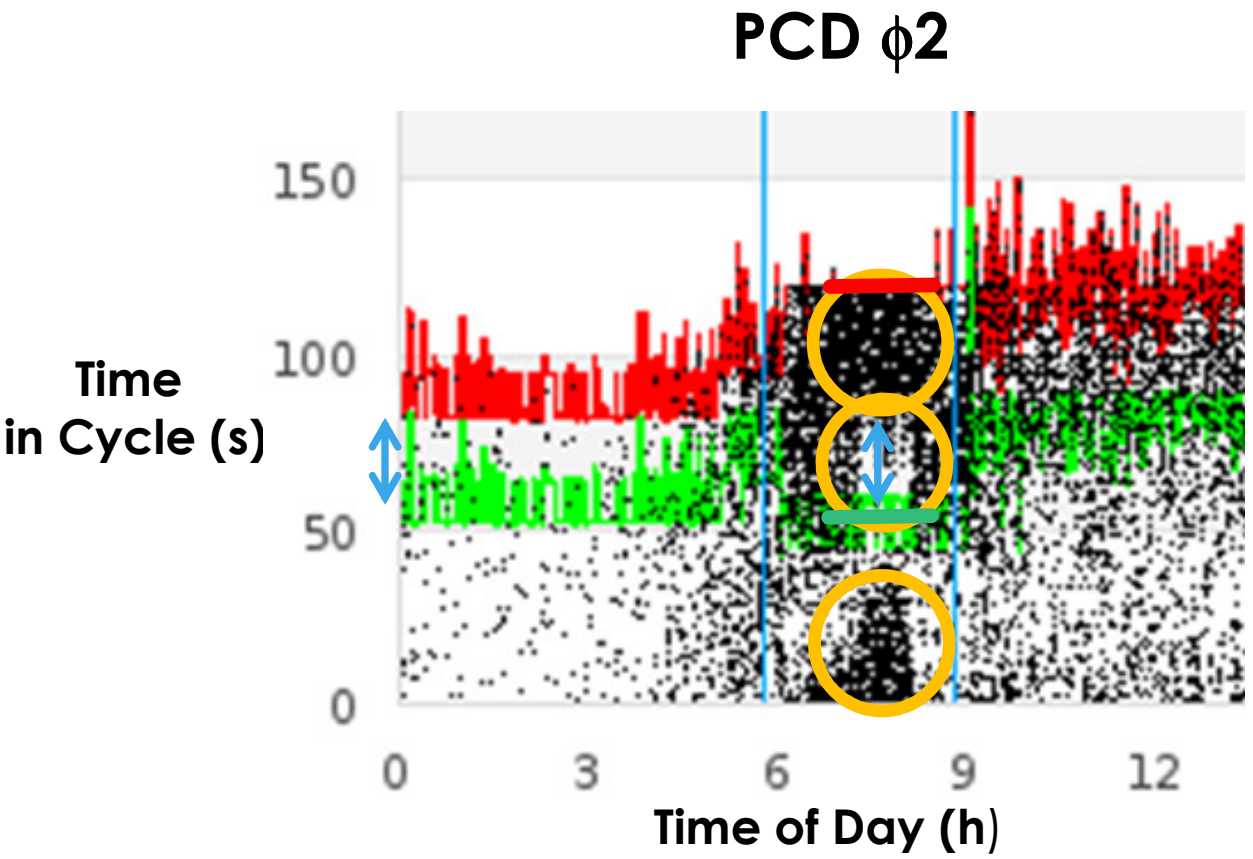
- **# SIGNALS TOTAL**
- **# SIGNALS ONLINE, AUTOMATICALLY STORING DATA & GENERATING PERFORMANCE MEASURE GRAPHS**
- **PEEK ATC, ECONOLITE ASC/3, SIEMENS M50 SERIES…**

# "Human-in-the-Loop-Adaptive"

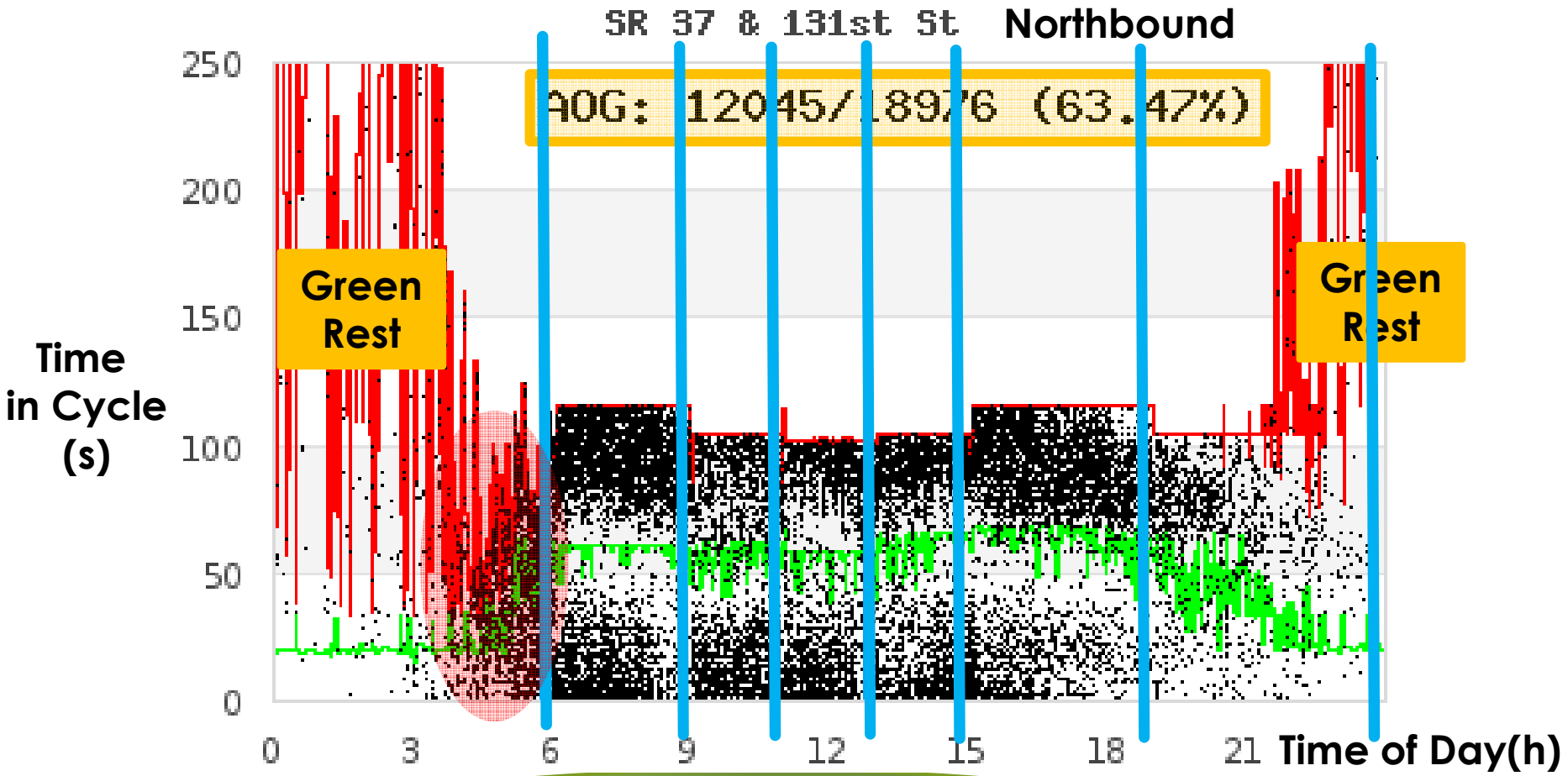
- **WEEKENDS & OFF-PEAKS**
- **ROUTINE RETIMINGS**
- **CONSTRUCTION SEASON:**
  - **You cannot be everywhere at once!**
  - **Could take Months for traffic to settle**
  - **Project in Flux:**
    - **Detection**
    - **Phases**
    - **Approaches / Lanes**
    - **Adjacent construction detours**

# Moving Forward:

- **CLOSELY-SPACED SIGNALS ALSO NEED ADVANCED DETECTION ON LEFT TURNS**
- **SEPARATE DETECTION CHANNELS FOR EACH LANE**


# PCD: Cycle Failure



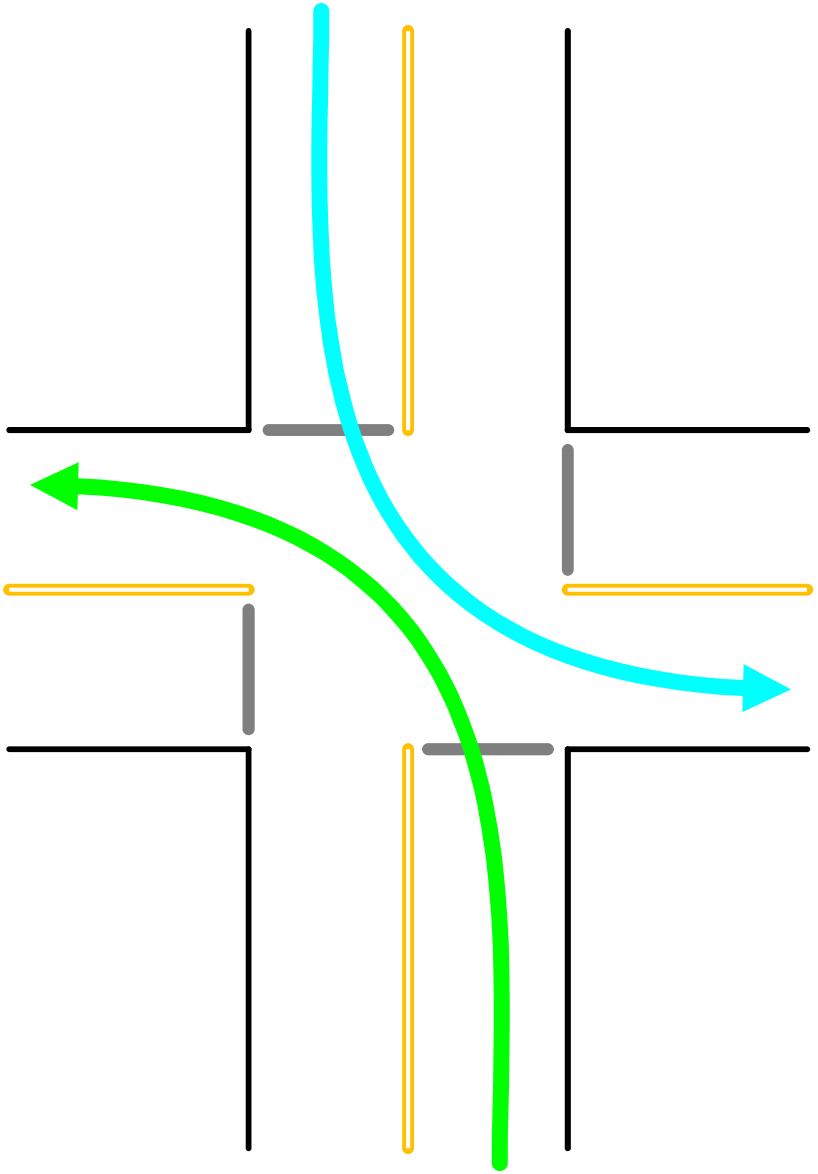

# PCD: Pattern Start & End Times

# Hi-resolution Event-based Data for Diamond Interchange Operations

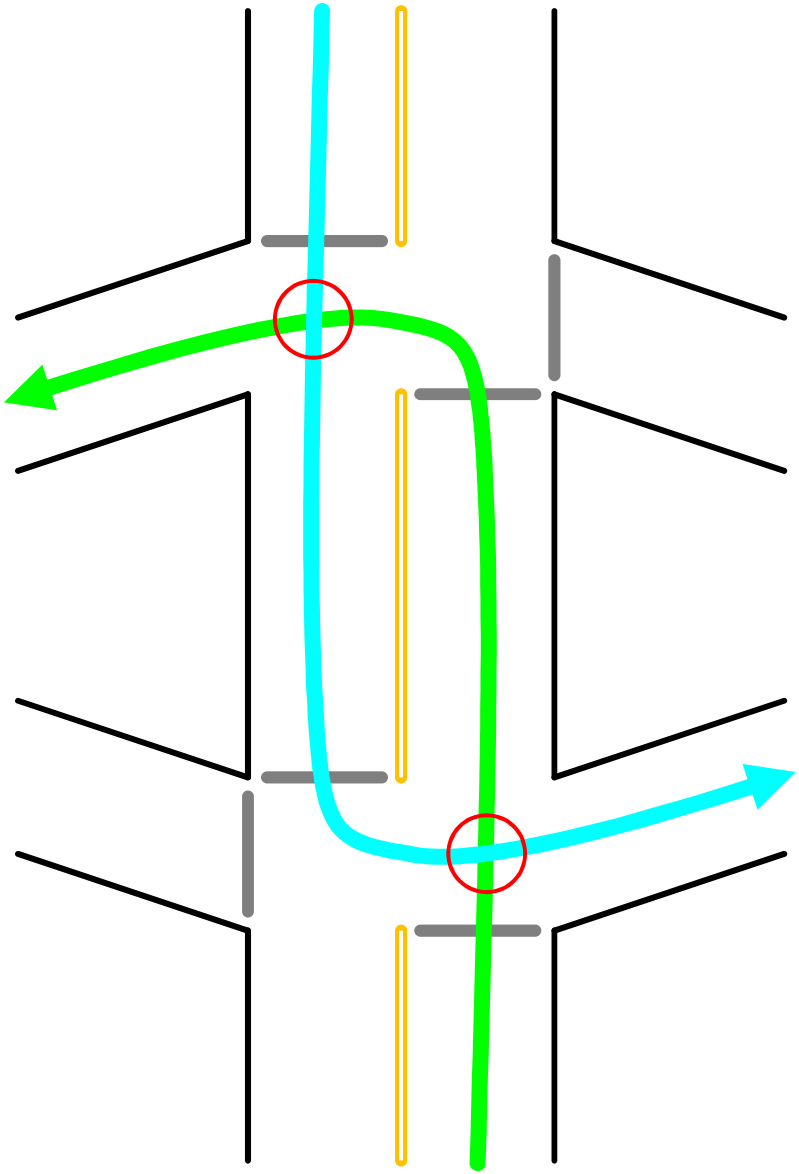
ALEX HAINEN
AMANDA STEVENS
CHRIS DAY
RICK FREIJE
JIM STURDEVANT
DARCY BULLOCK
HOWELL LI

# Diamond Interchanges

*What are they and why do the matter?*



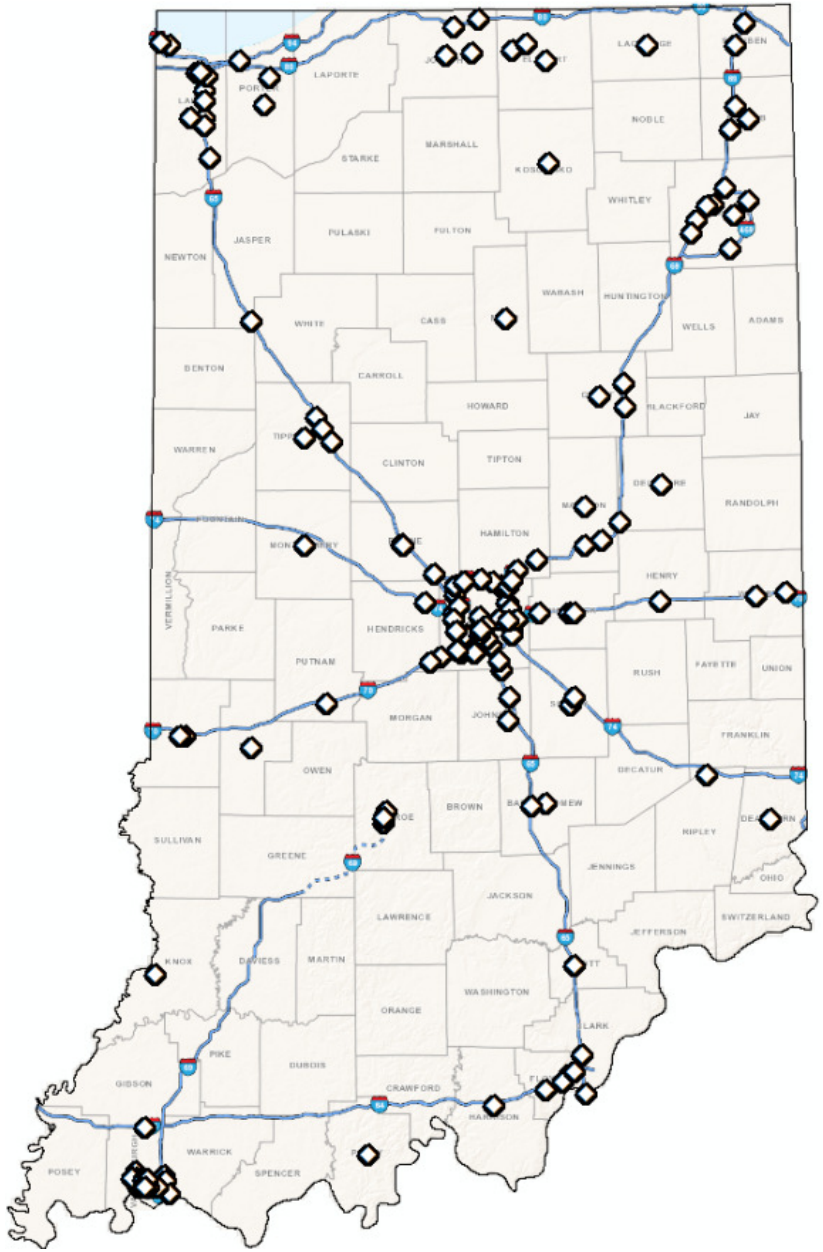
Normal Intersection

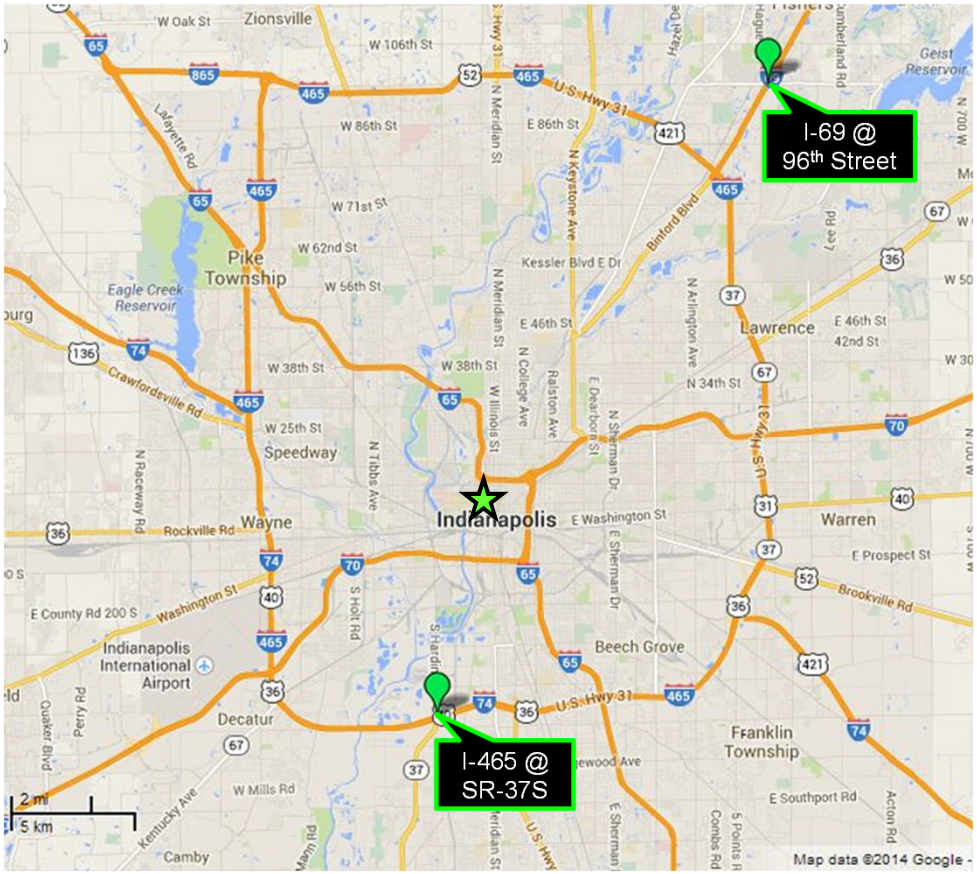


Diamond Interchange

# Diamond Interchanges

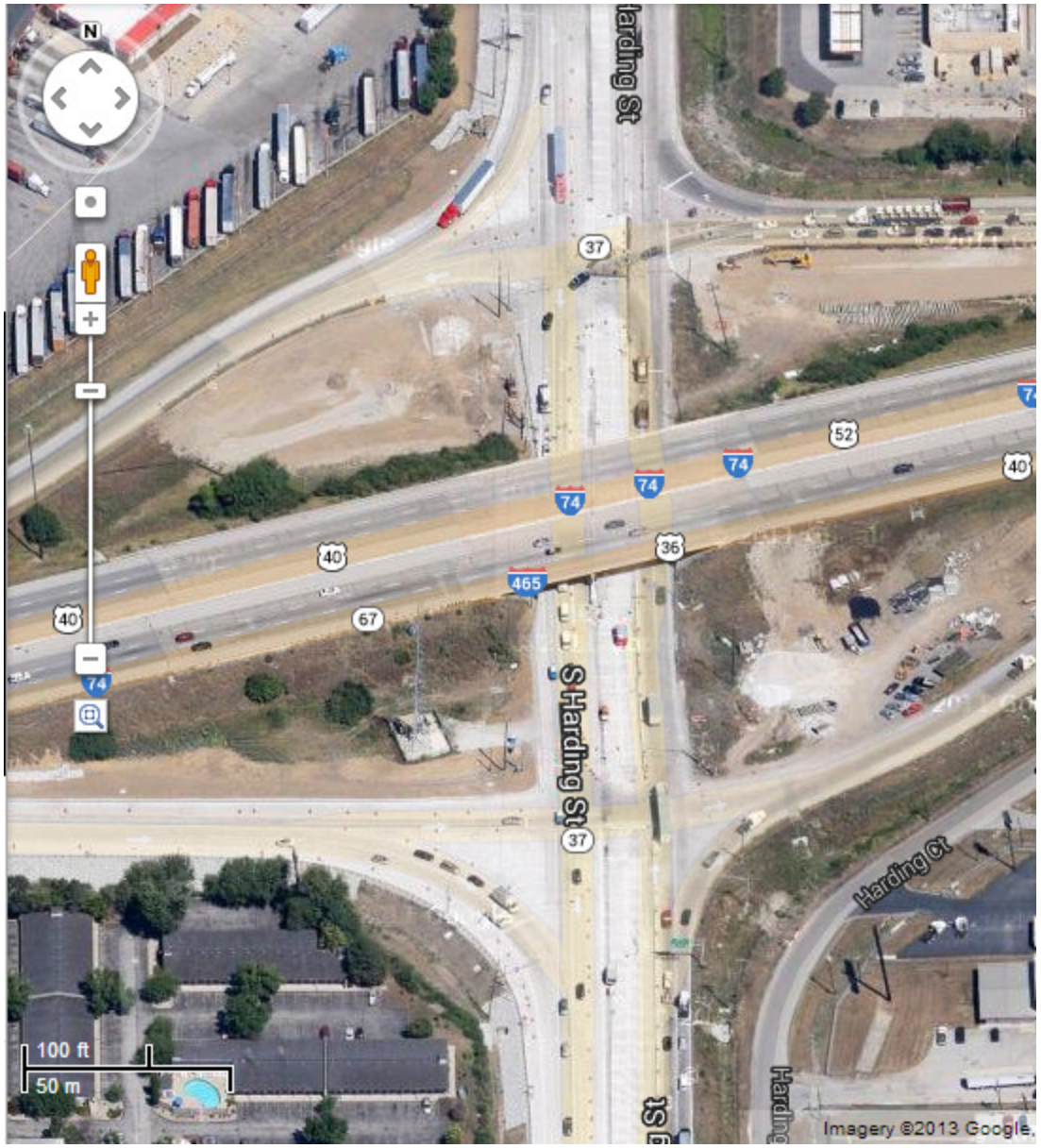
*Indiana = 161 Interchanges*  *Nationally >= 10,000*

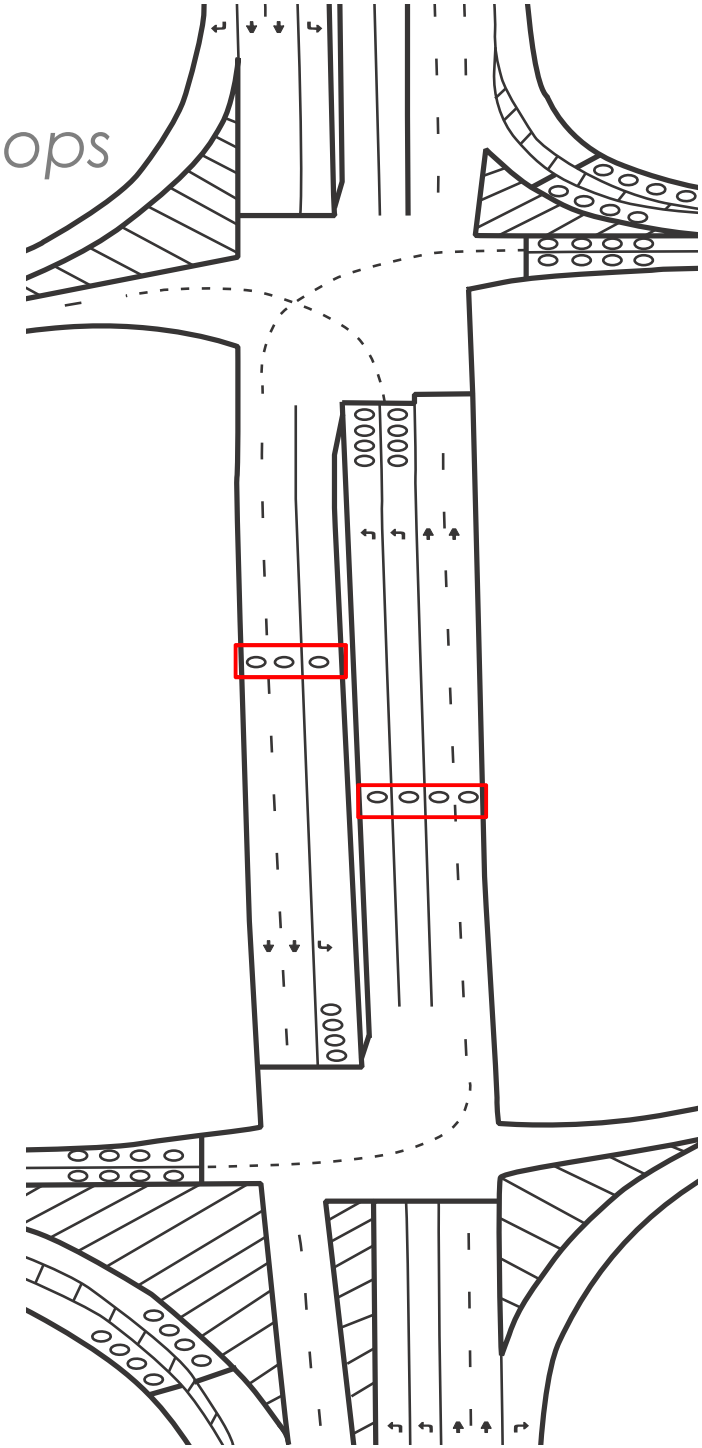


# I-465 @ SR-37

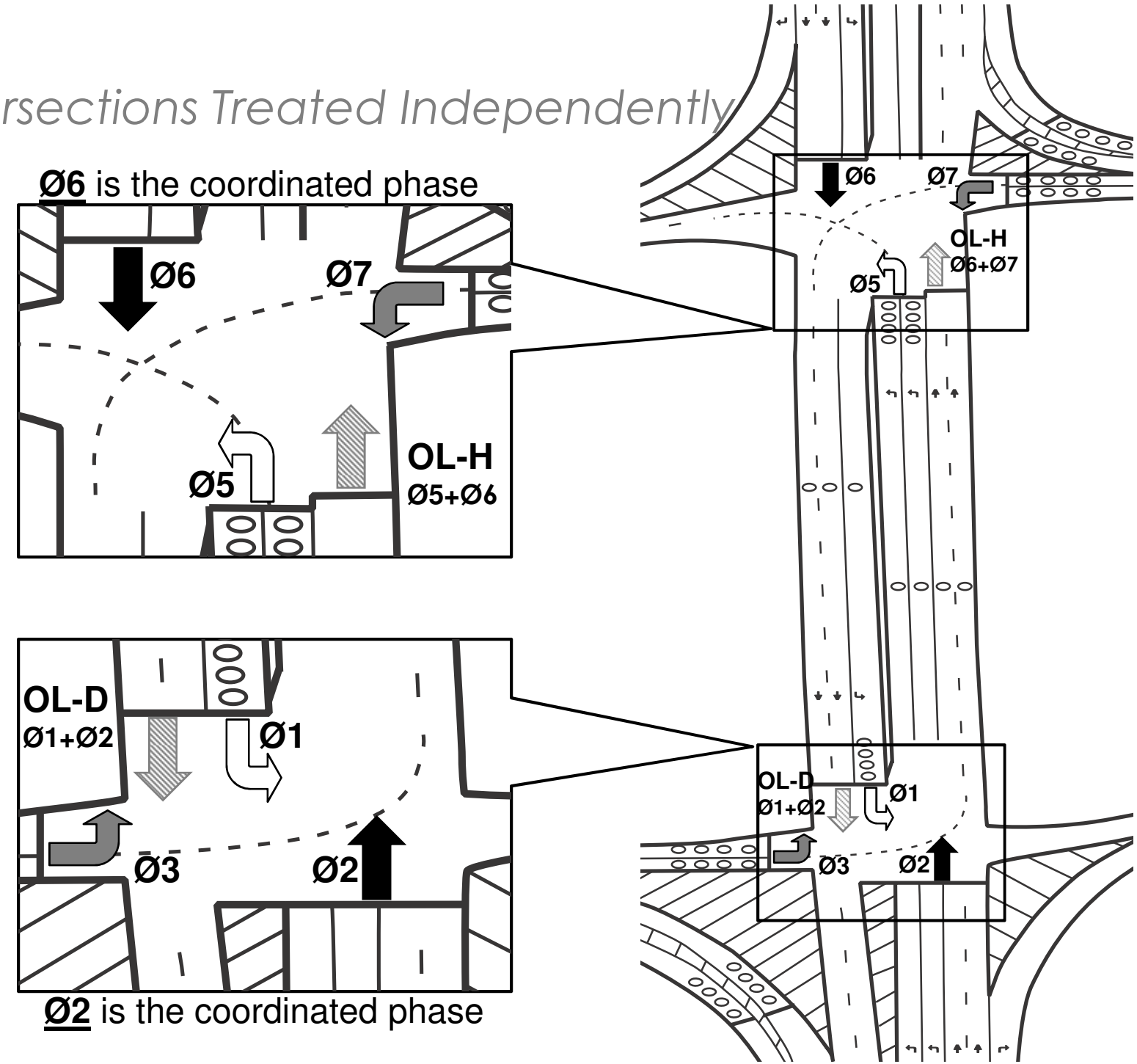
*Diamond Interchange w/Advanced Loops*



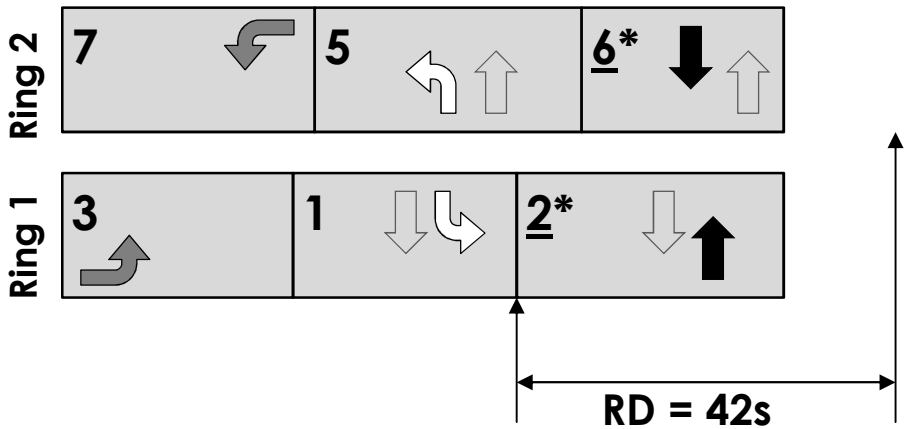
# Phasing

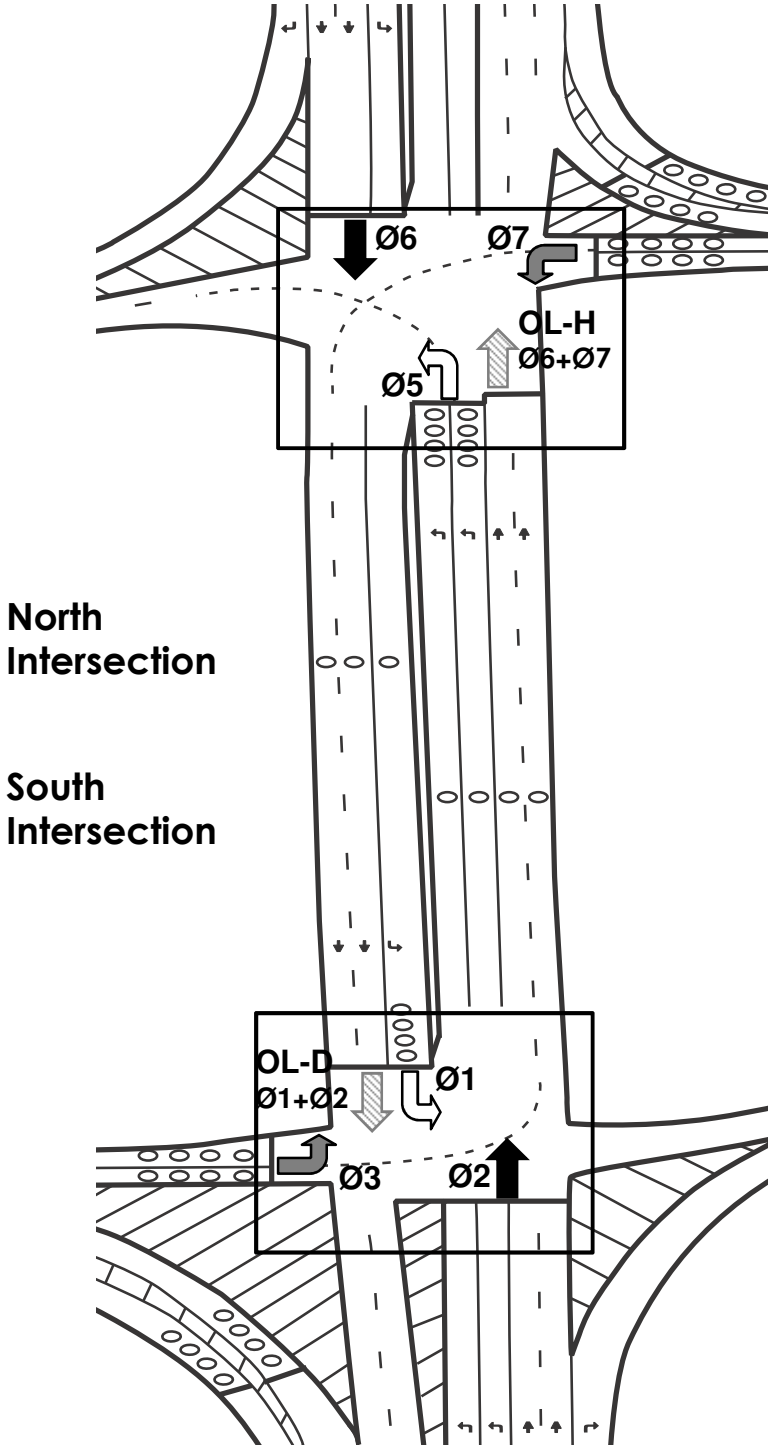
*Two "T"-Intersections Treated Independently*



# Ring Displacement

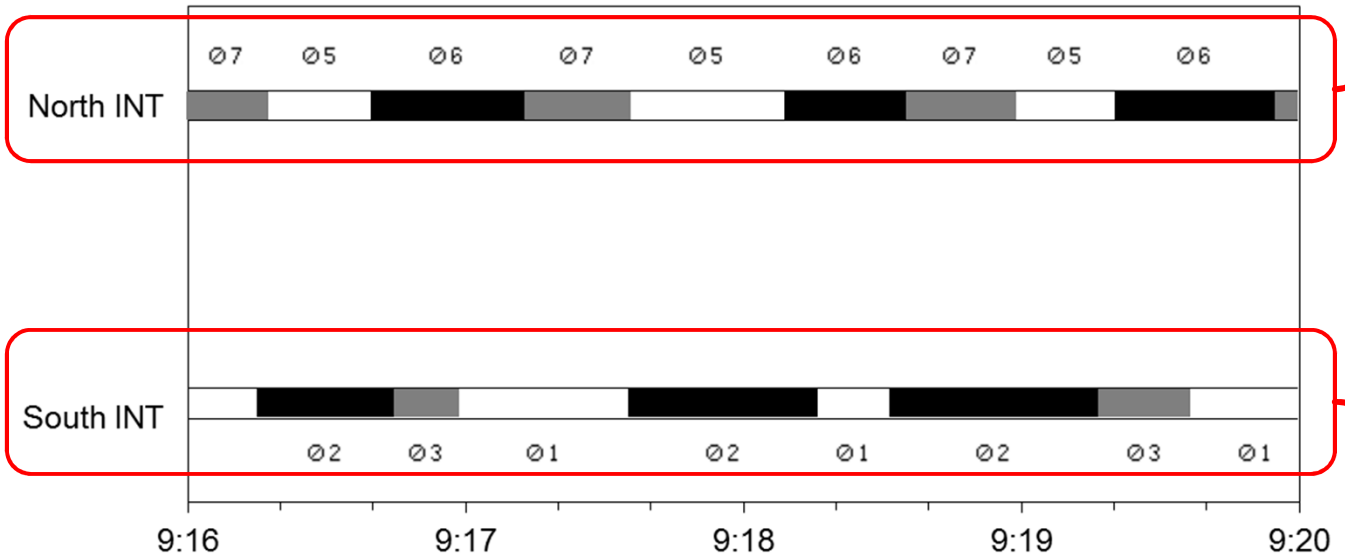
*Offset Between Coordinated Phases*

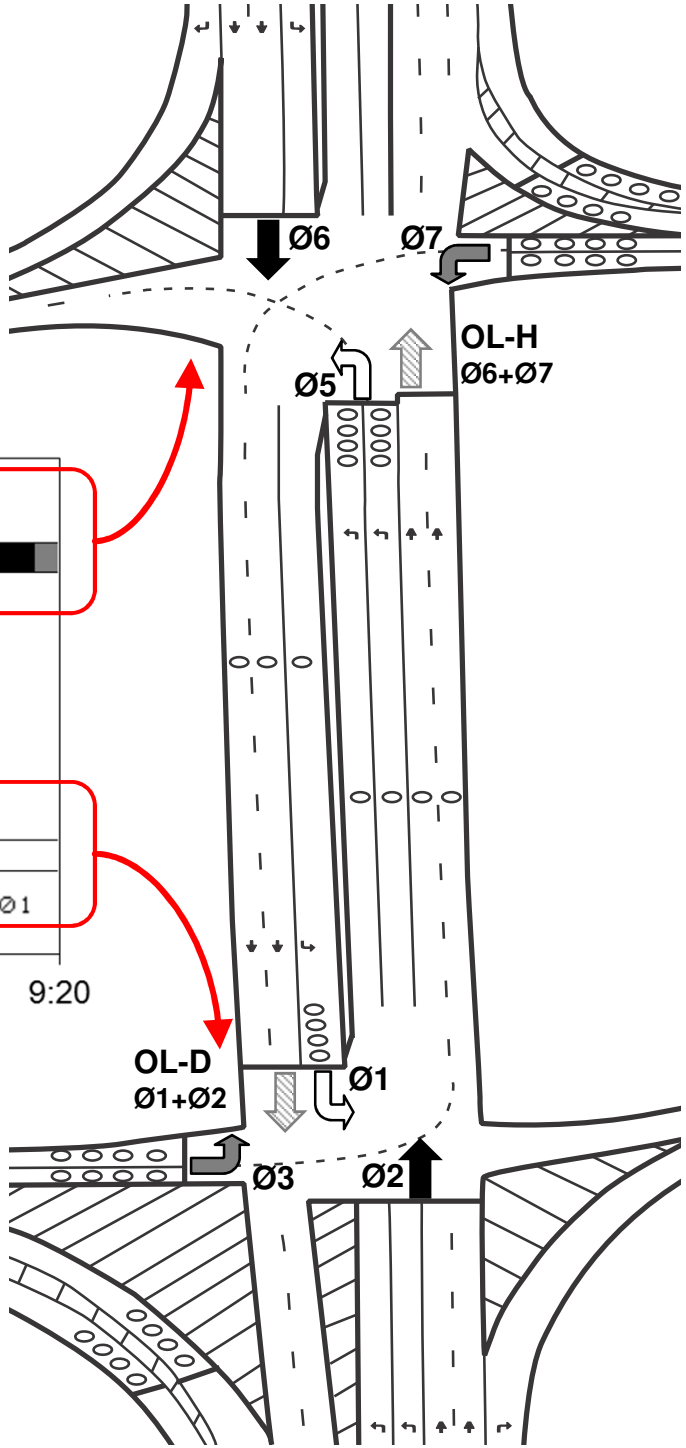


# Ring Structure

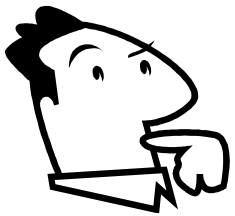
*From the HiRes Data, Plot the Rings*

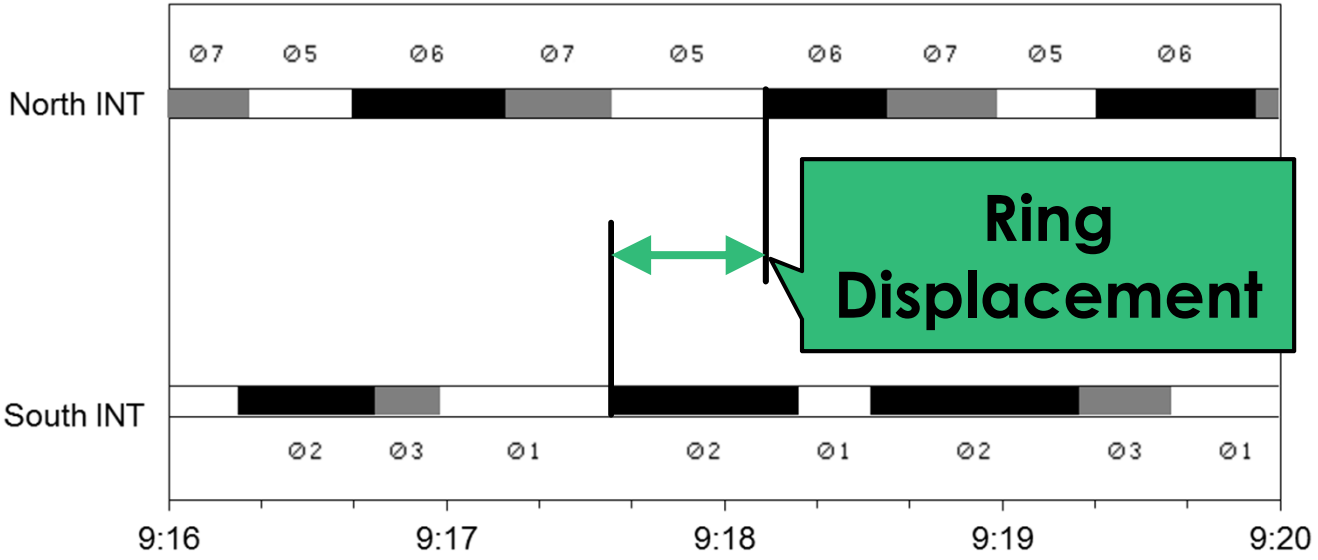


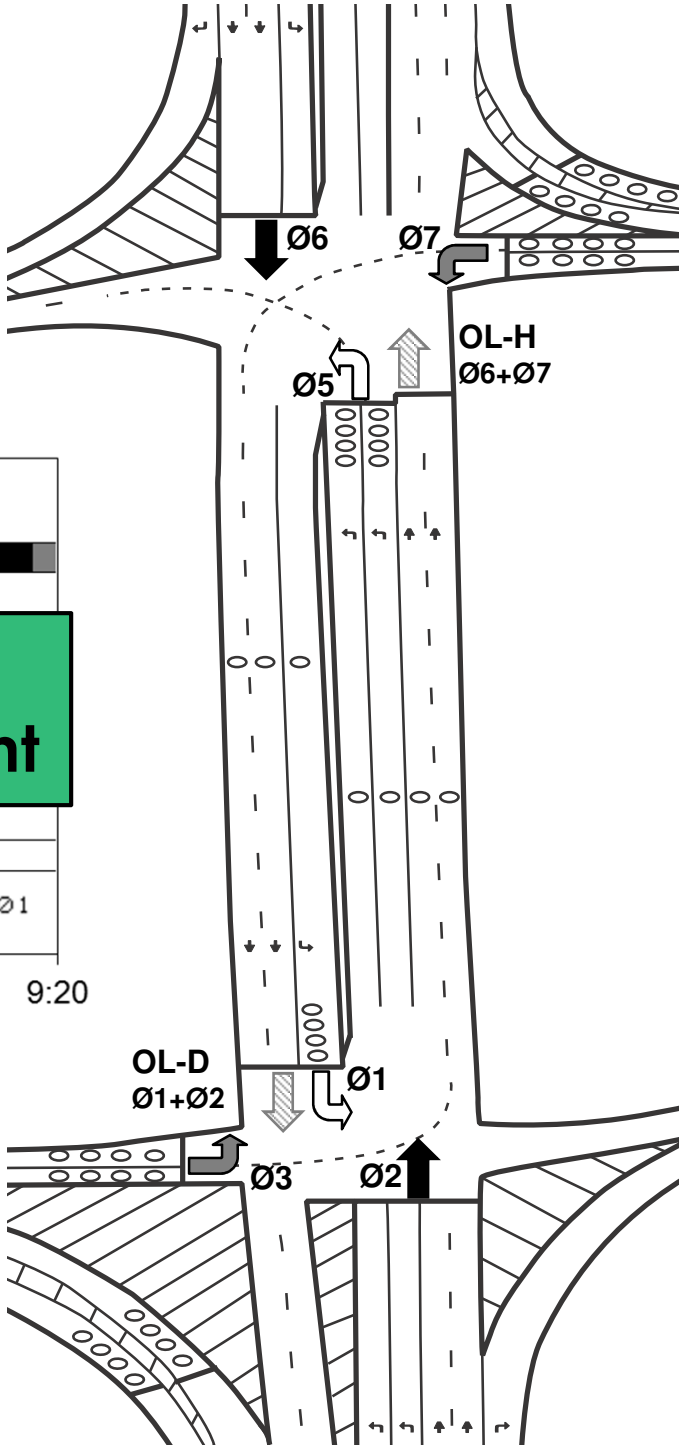



# Ring Displacement

*How is this parameter set?*





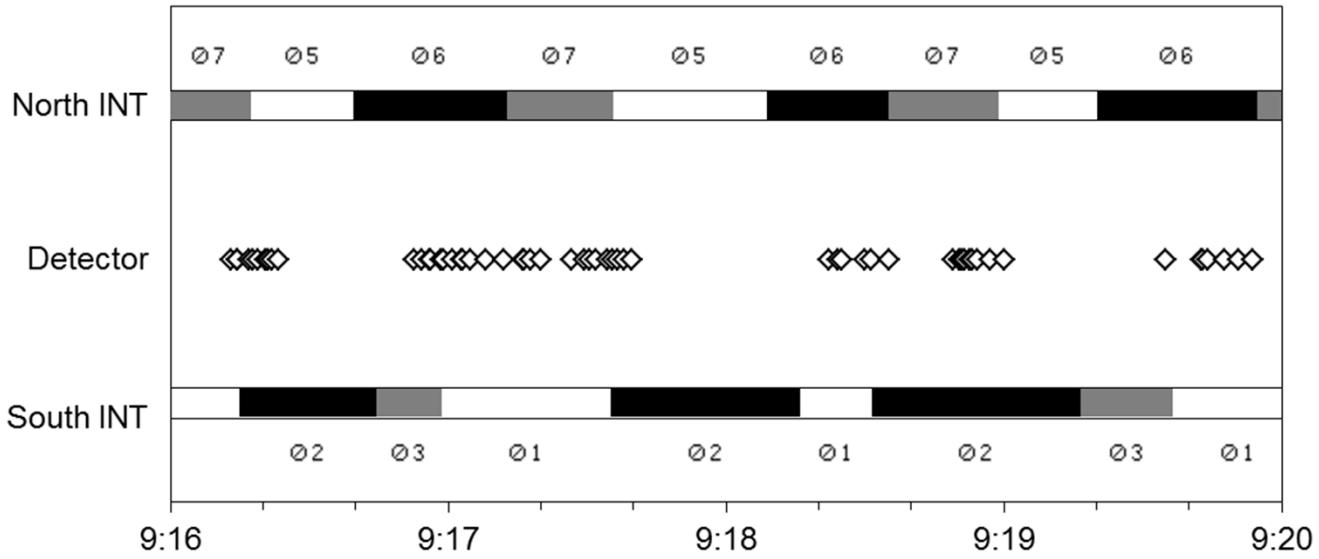



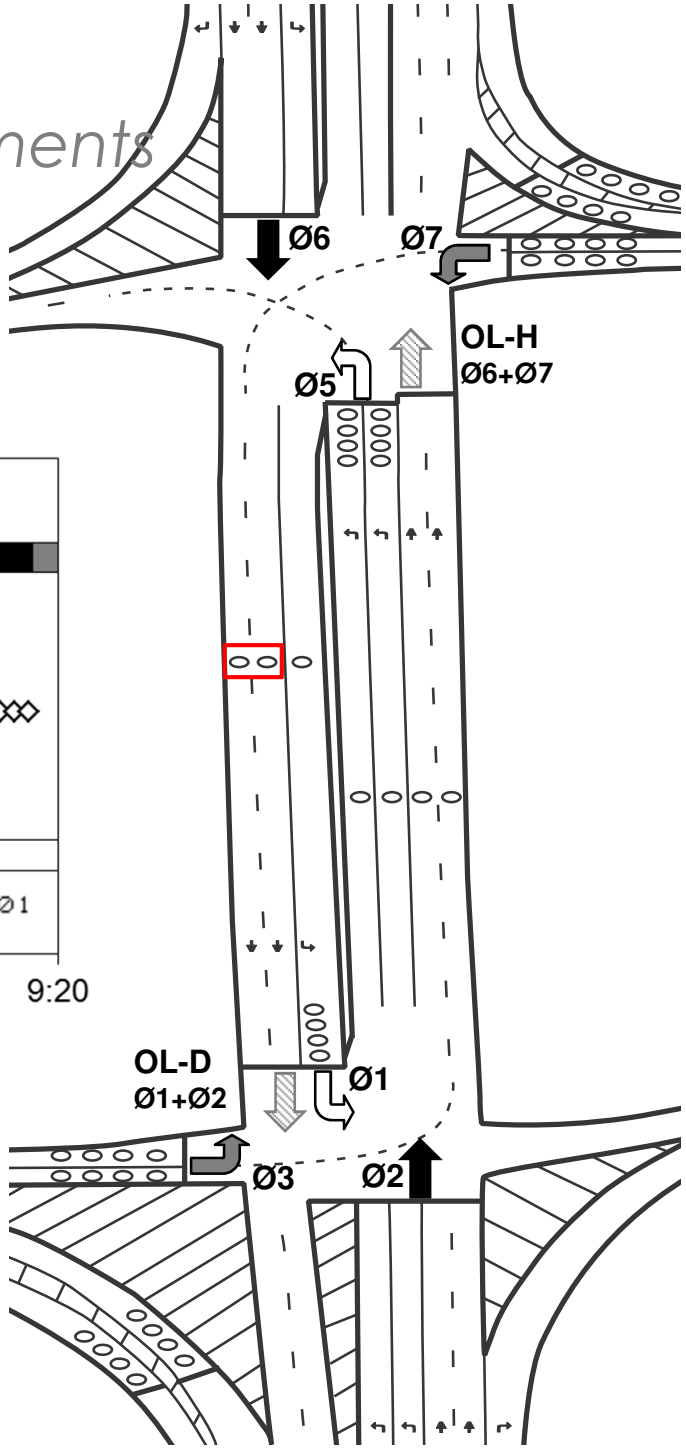

```
COORDINATOR PATTERN [  1]                ^v
TS2 (PAT-OFF)..   0-1
CYCLE.........     0s STD (COS)......111
OFFSET VAL.....    0s DWELL/ADD TIME.  0
ACTUATED COORD...  NO TIMING PLAN....
ACT WALK REST....  NO SEQUENCE........
PHASE RESRVCE....  NO ACTION PLAN....
MAX SELECT.....  NONE FORCE OFF.... NONE
SPLIT PREFERENCE PHASES
 PHASE[s] 1   2   3   4   5   6   7   8
SPT[  1] 0   0   0   0   0   0   0   0
PREF 1... 0   0   0   0   0   0   0   0
PREF 2... 0   0   0   0   0   0   0   0
SPLT EXT...0s. 0s  0s  0s
VEH PERM.  0s  0s  0s  DISP
RING DISP  -   0s  0s  0s (RING 2-4)
```

```
DIAL 1 SPLIT 1 PARAMETERS
 OFFSET TIME  ALT  PATN  R2   R3   R4
   #     SEC  SEQ  MODE  LAG  LAG  LAG
   1       0    0     0
   2       0    0     0
   3       0    0     0
MODE (0-6): NRM/PRM/YLD/PYL/POM/SOM/FAC
A-UP B-DN C-LT D-RT E-ENTER F-PRIOR MENU
```

# SB Thru Detectors

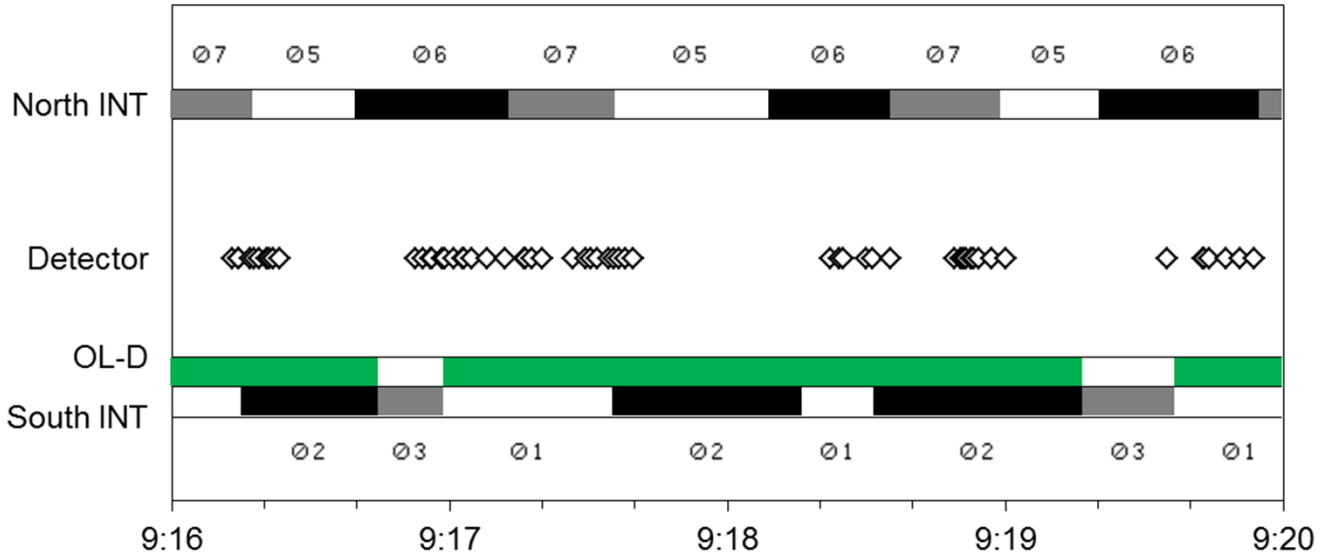
*Consider one of the four internal movements*

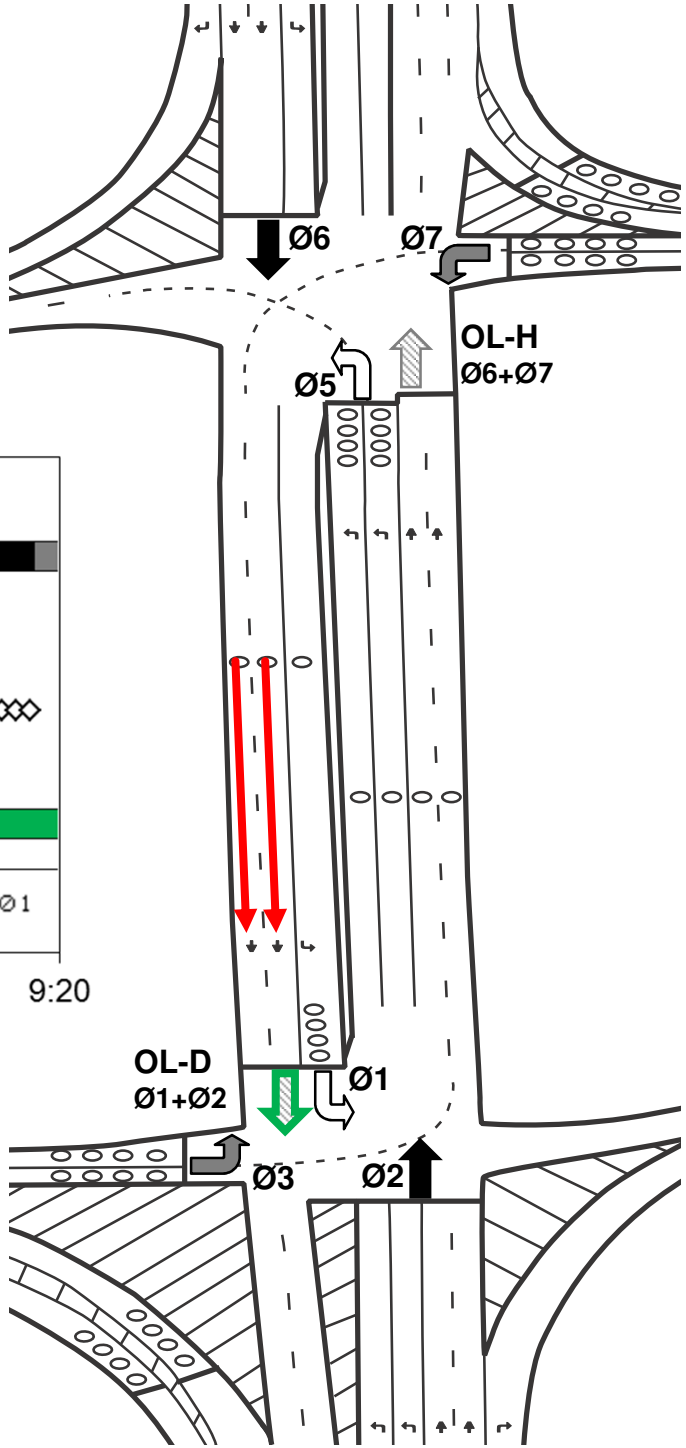


# Arrival on Green?

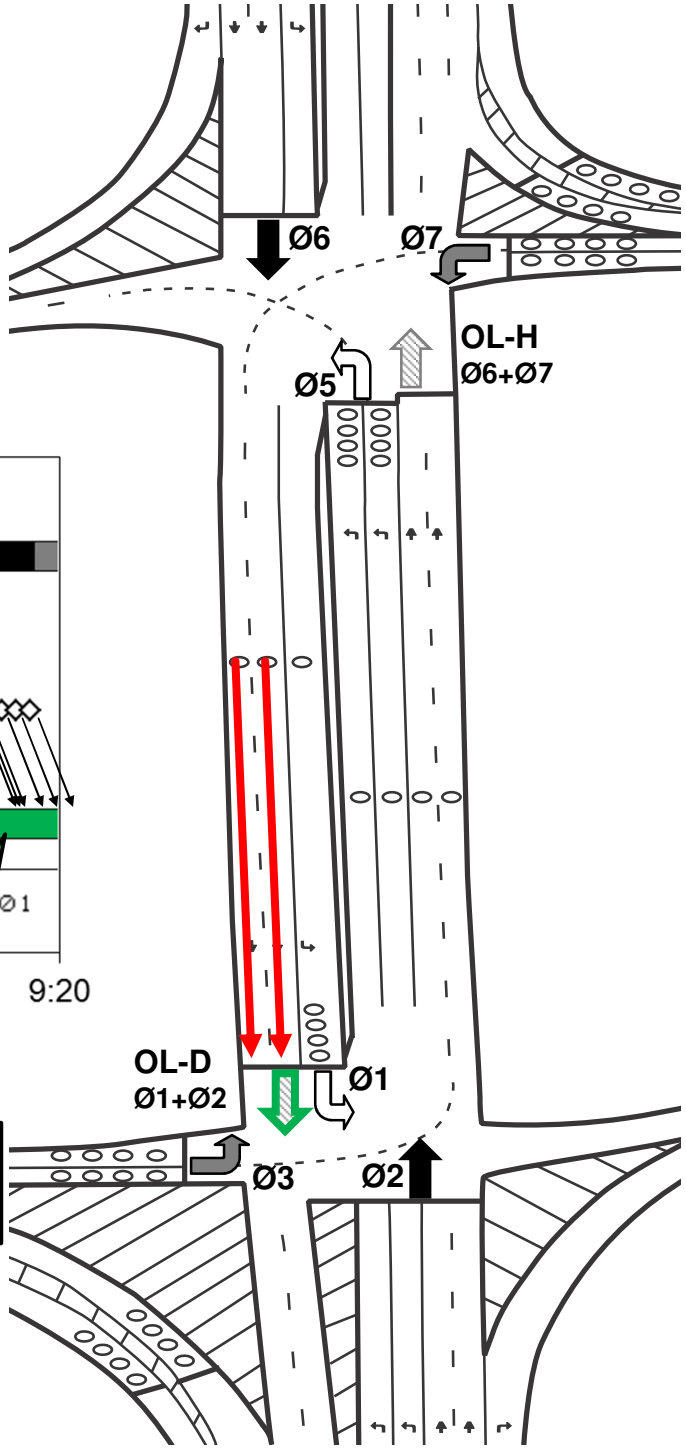
*Plot the green status of the overlap*



# Project the Detector Data

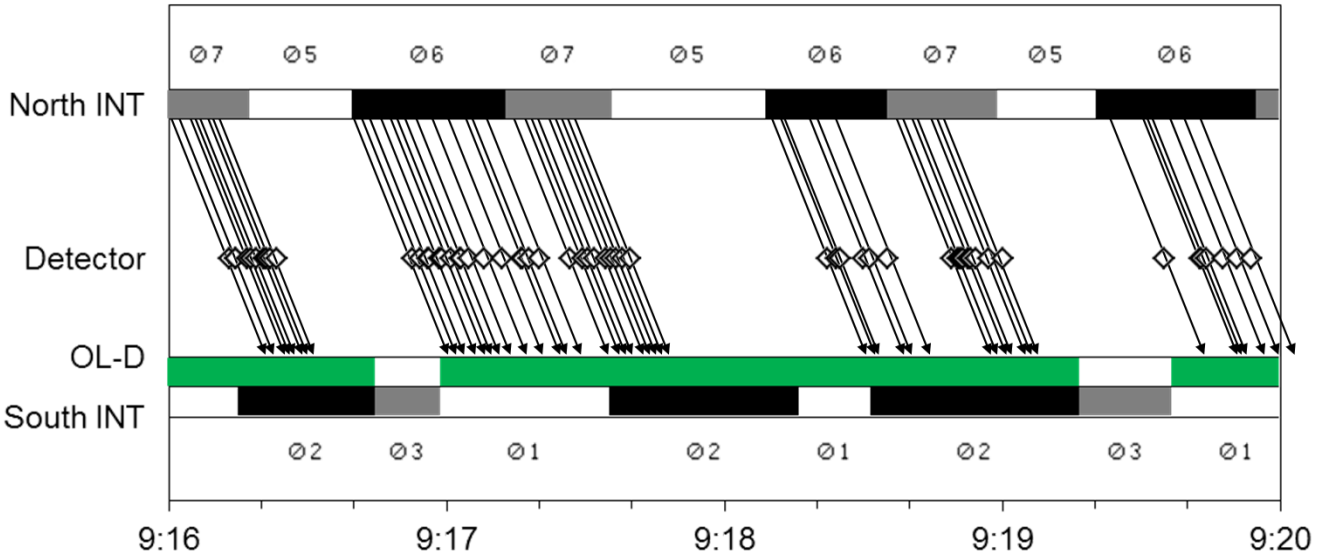
*295' upstream ≈ 5 seconds @ 40 MPH*

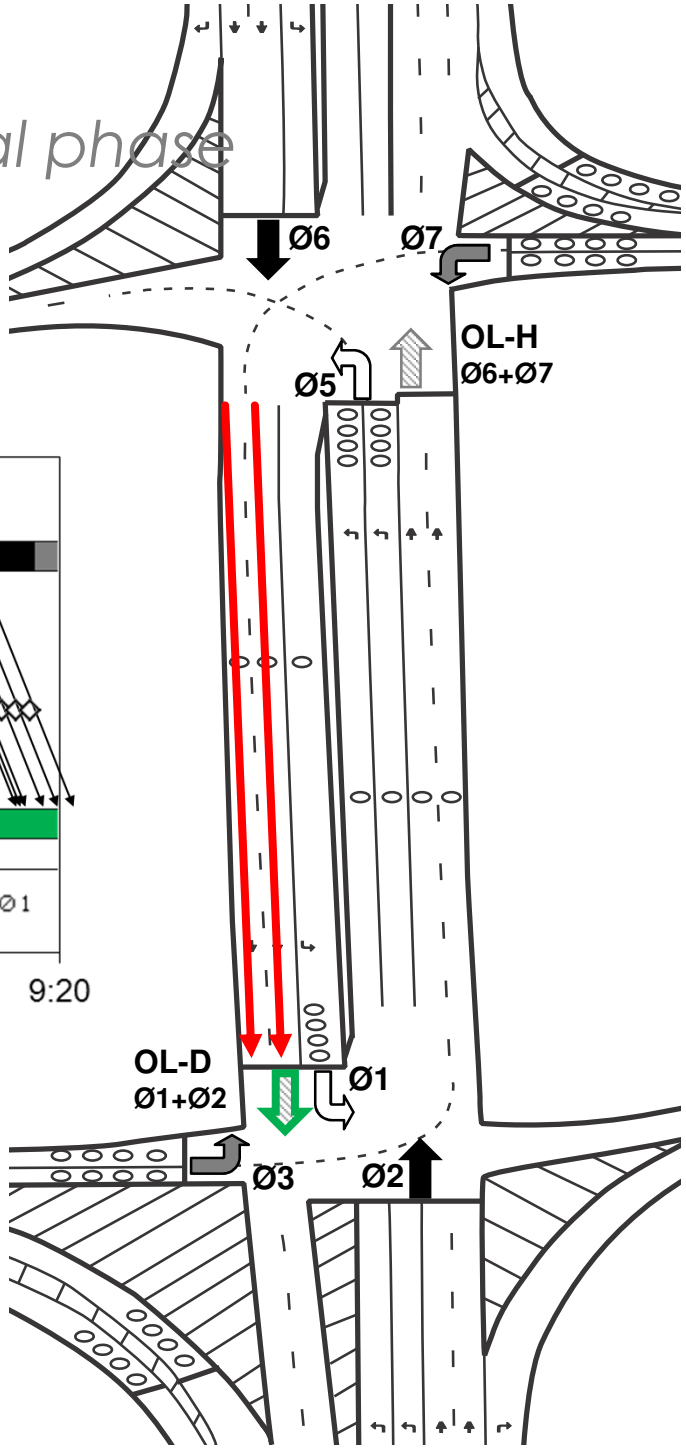




**The engineer who set the ring displacement did a fantastic job at arrivals on green for this movement!**

# Upstream Source Phase?

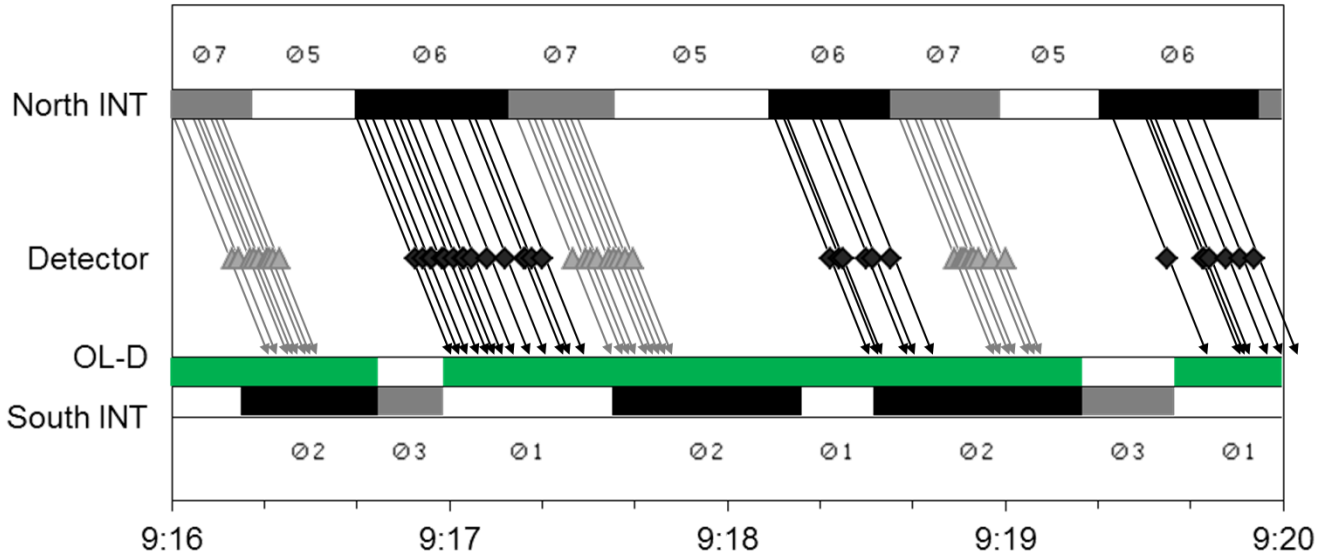
*Look upstream ~10 seconds at the signal phase*

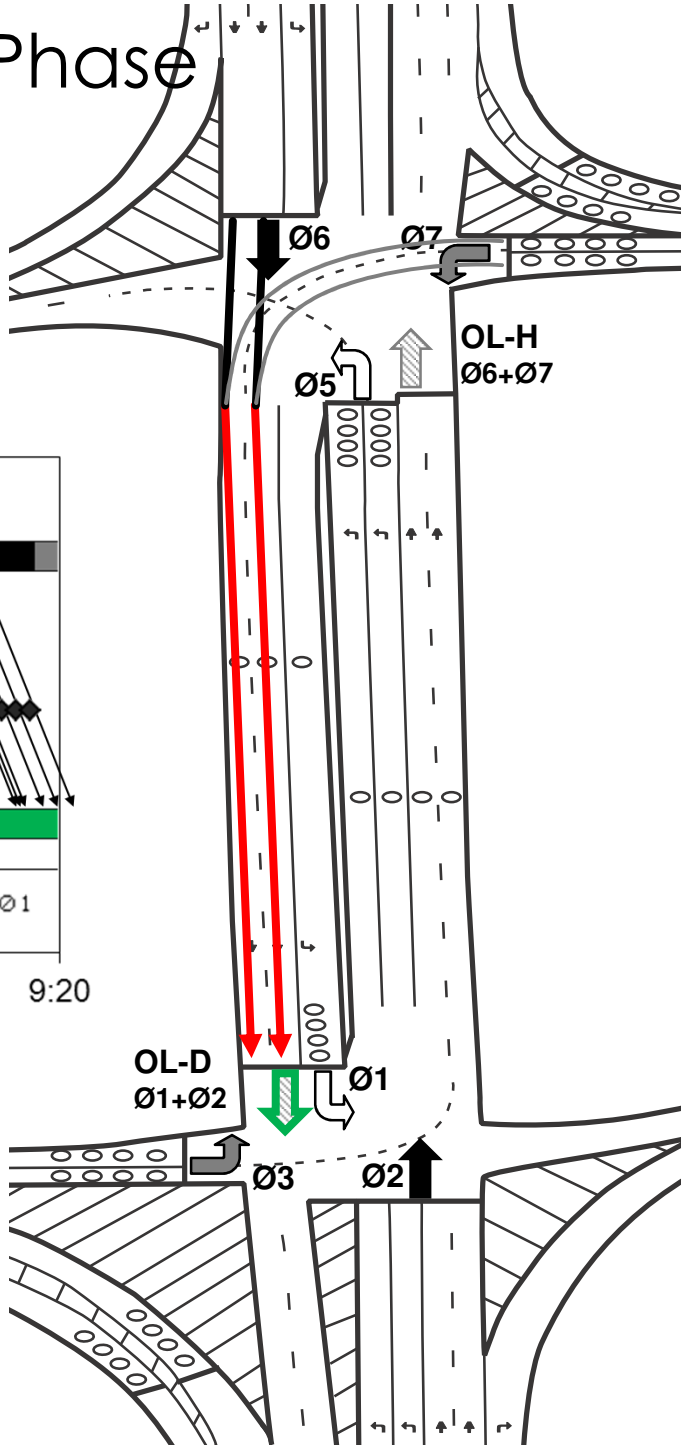


# Now Platoons are Attributed to a Phase

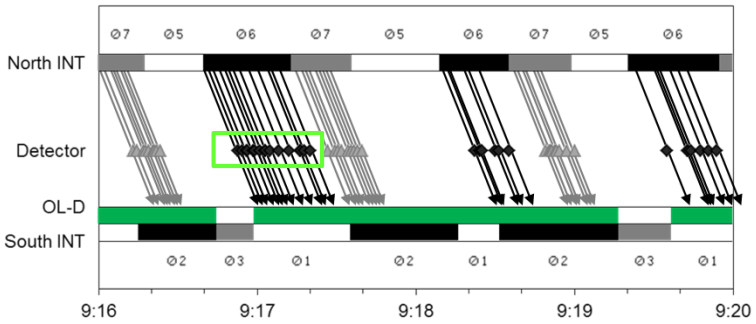
*The vehicles' sources are known*

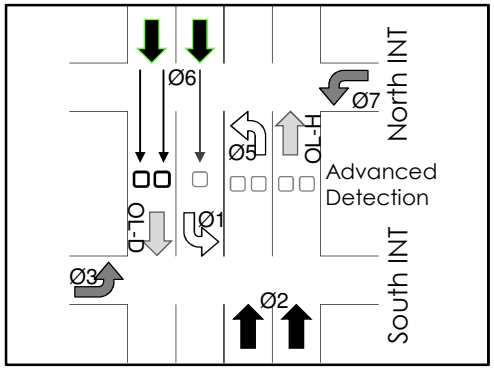


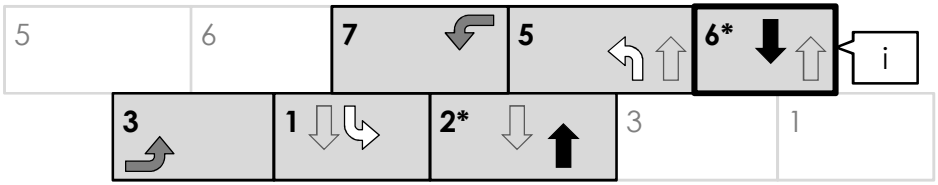



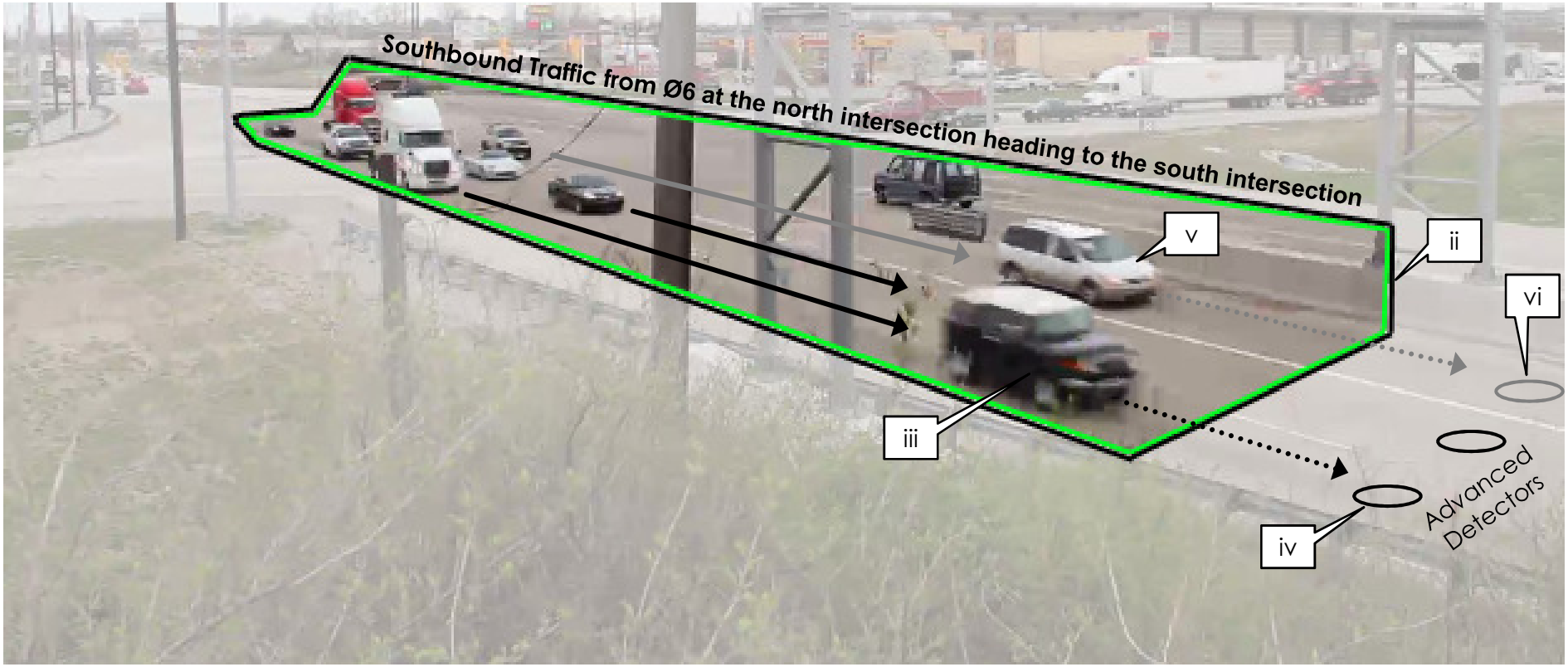
# Traffic from SBT

*Vehicles from Ø6*



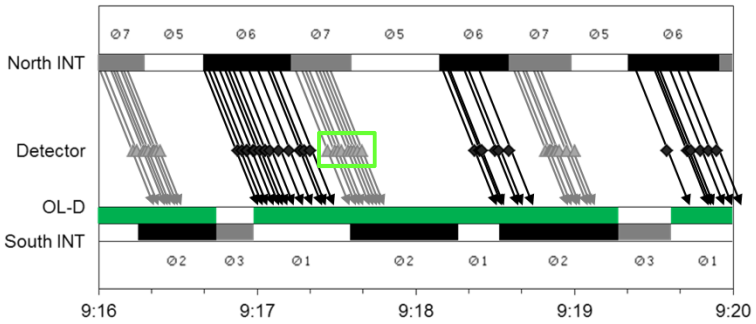



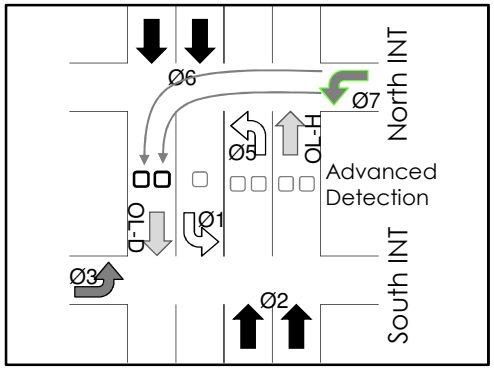



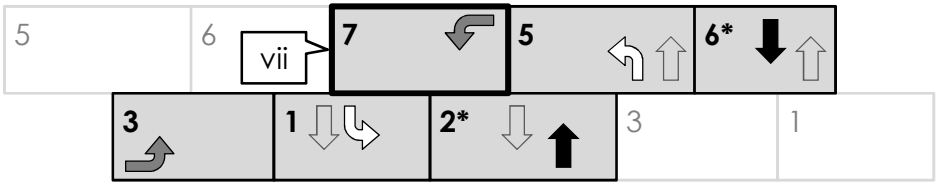



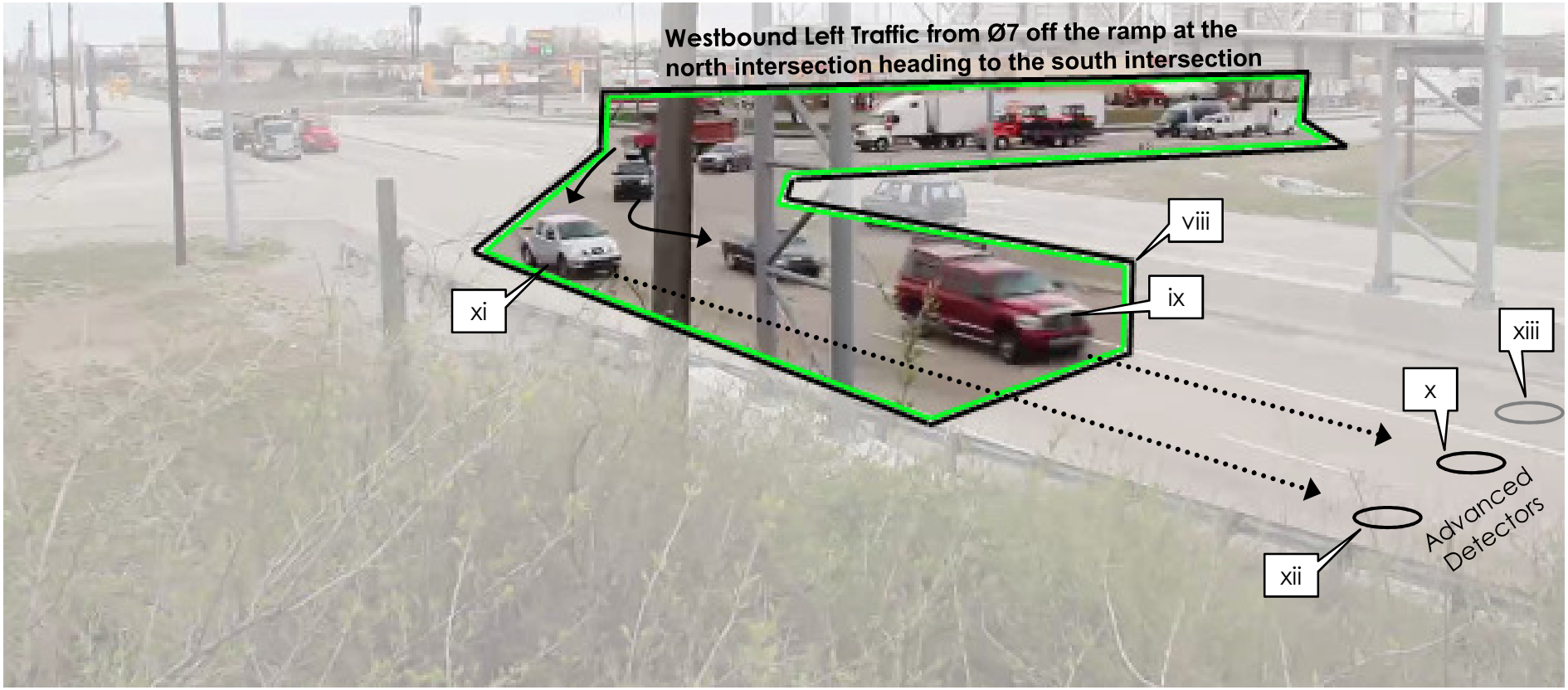
# Traffic from WBL

## *Vehicles from Ø7*



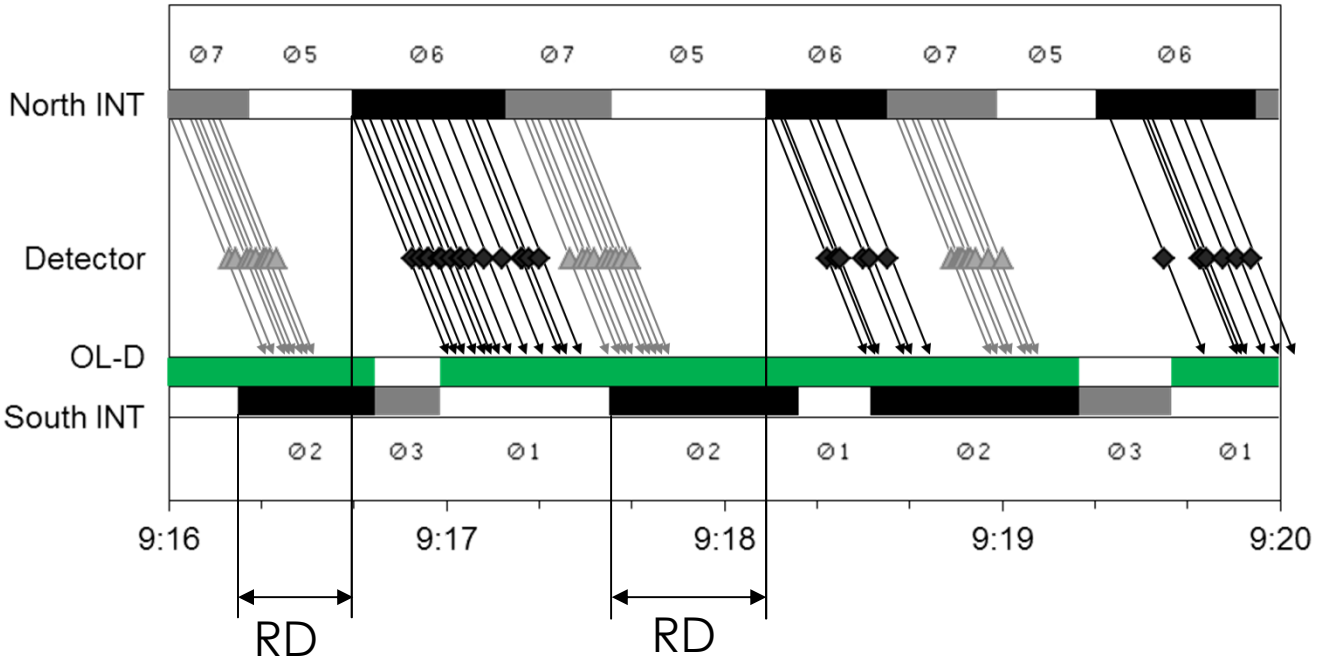



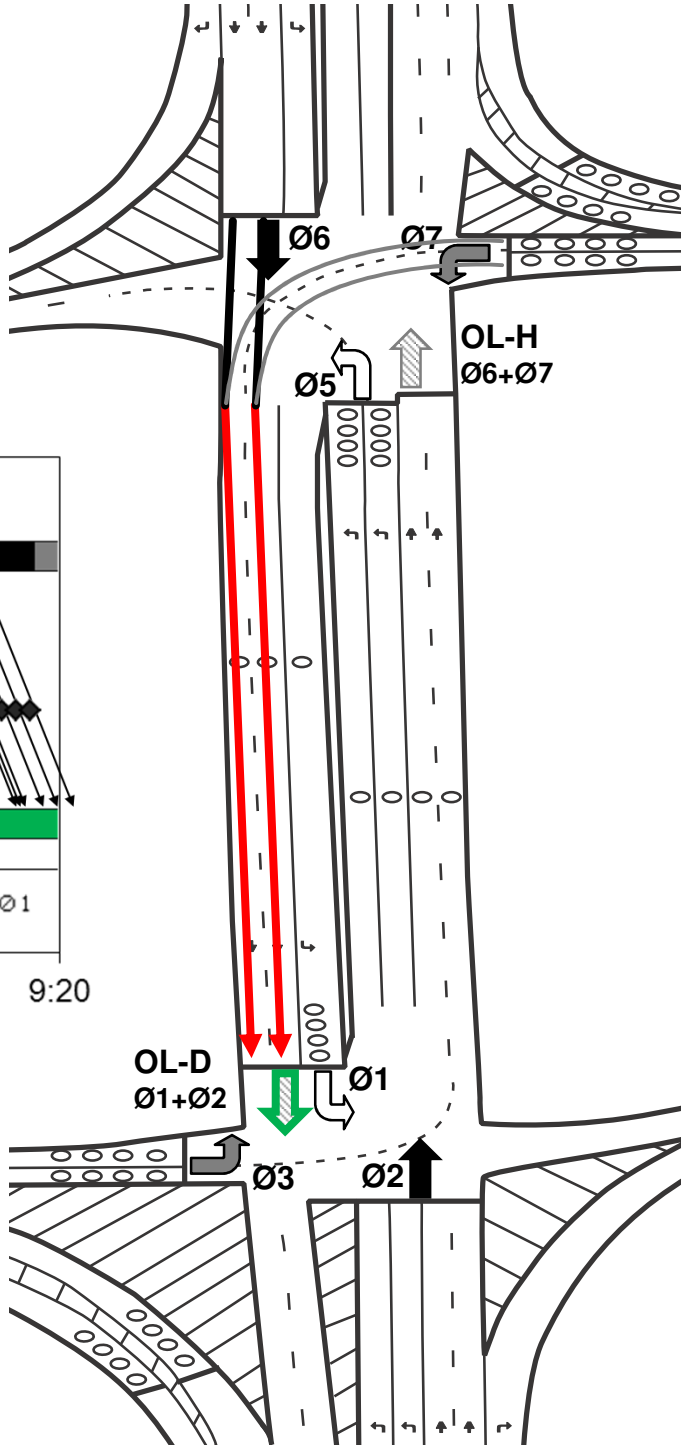



# Adjusting the ring displacement

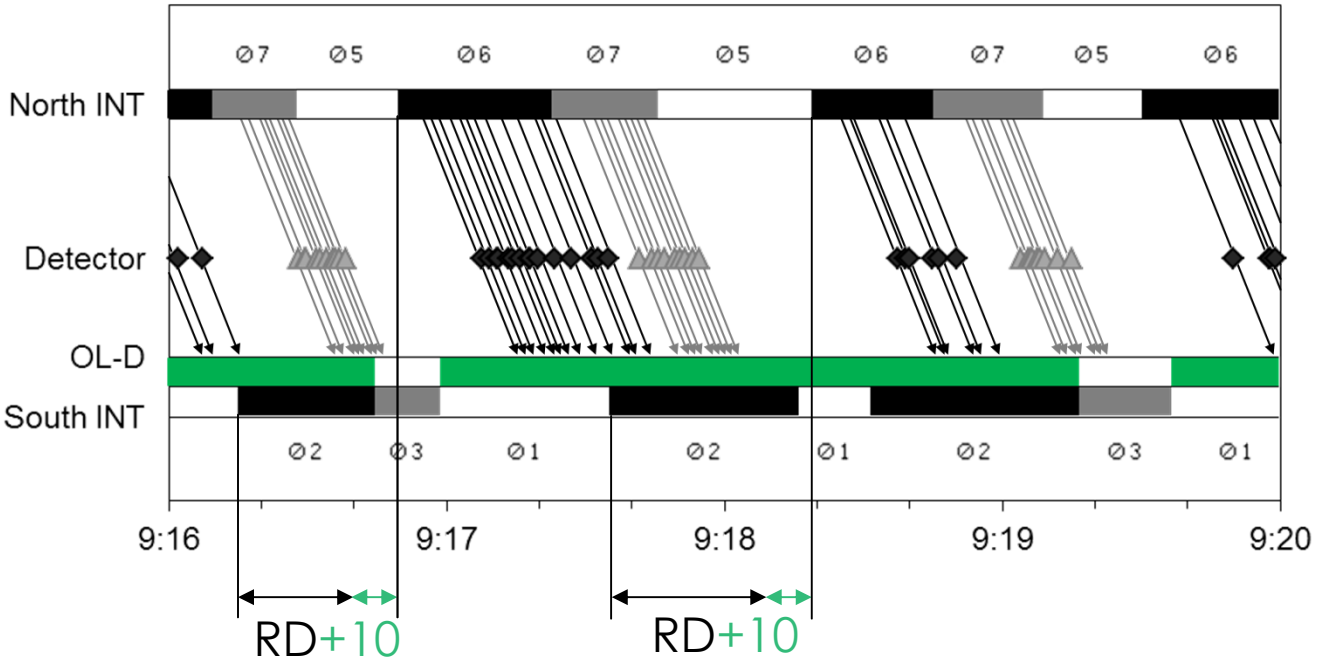
*What effect would it have?*

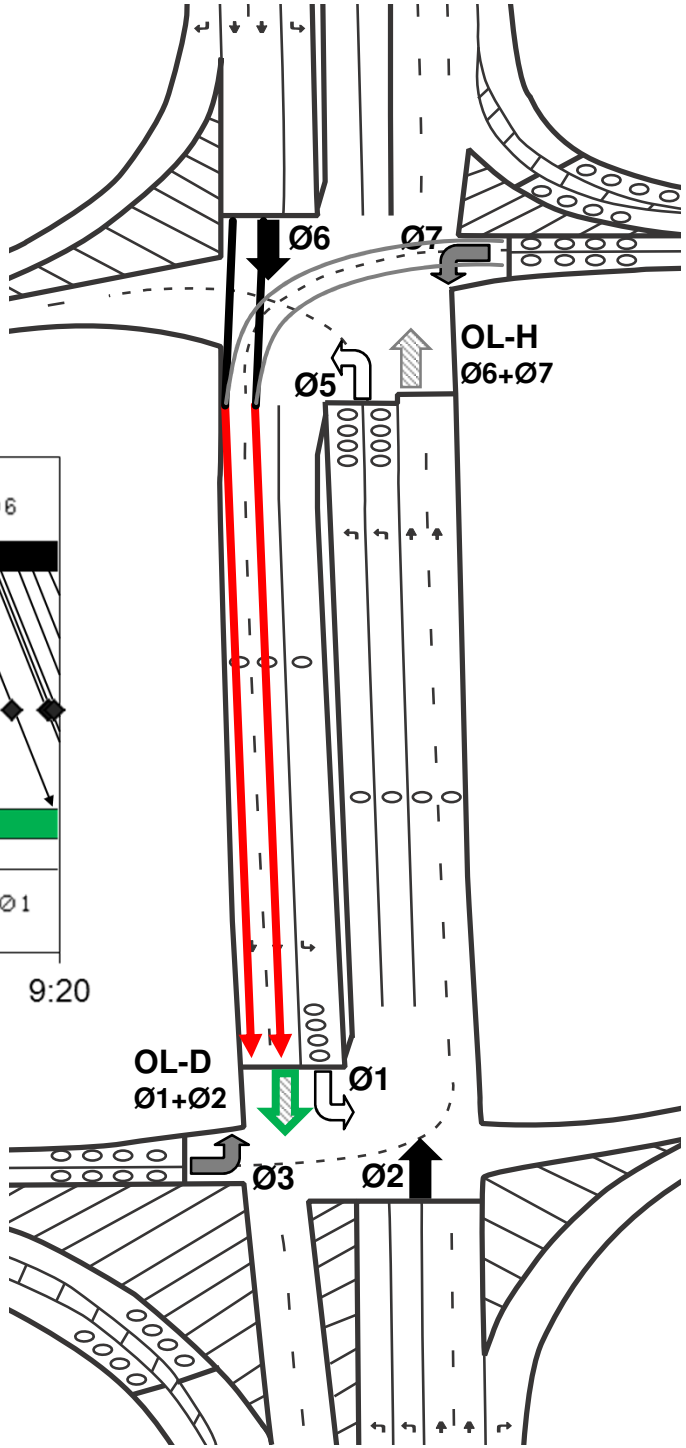


# Ring Displacement **+10 Seconds**

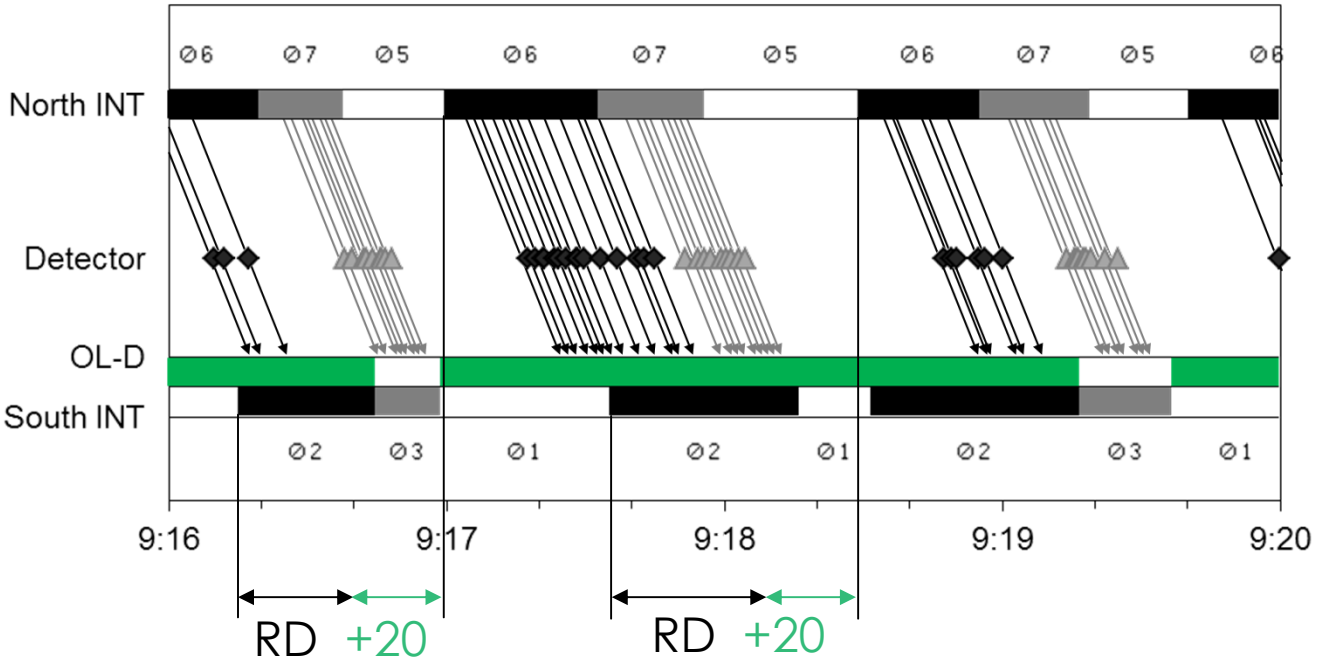
*What effect would it have?*

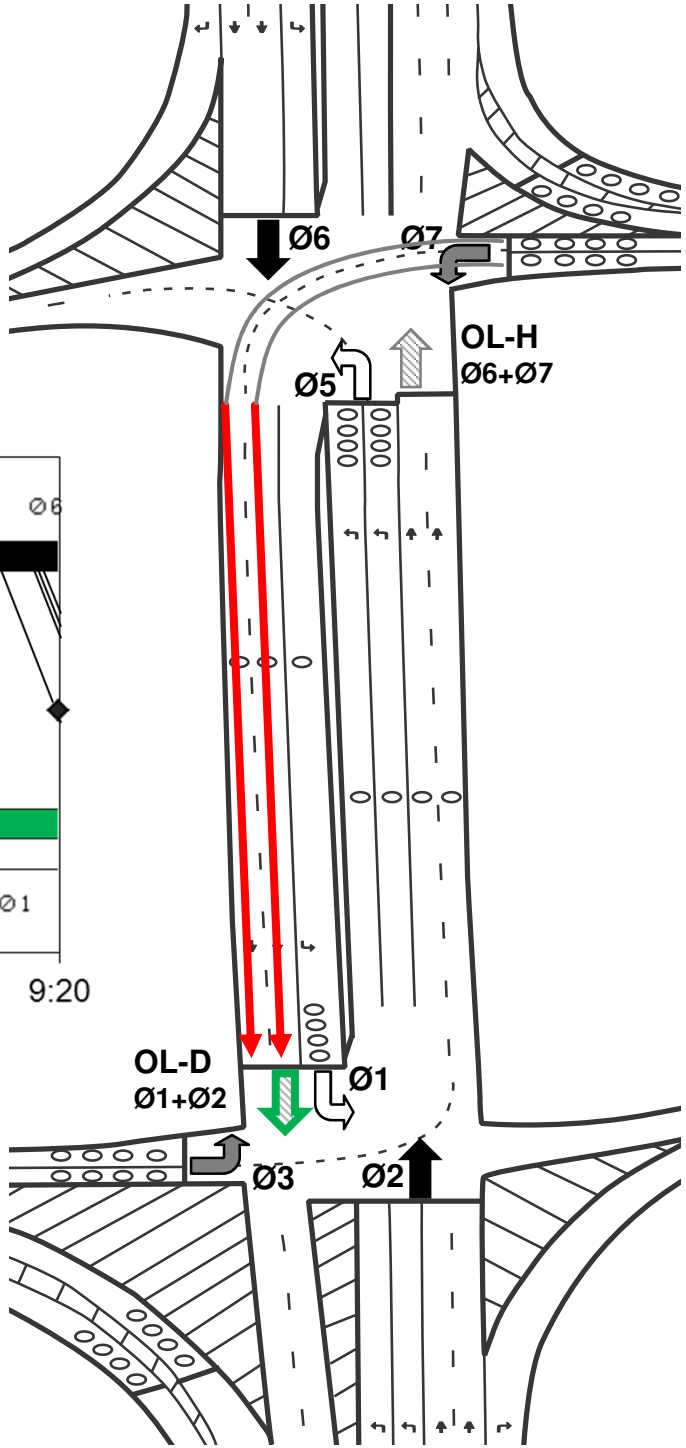


# Ring Displacement **+20 Seconds**

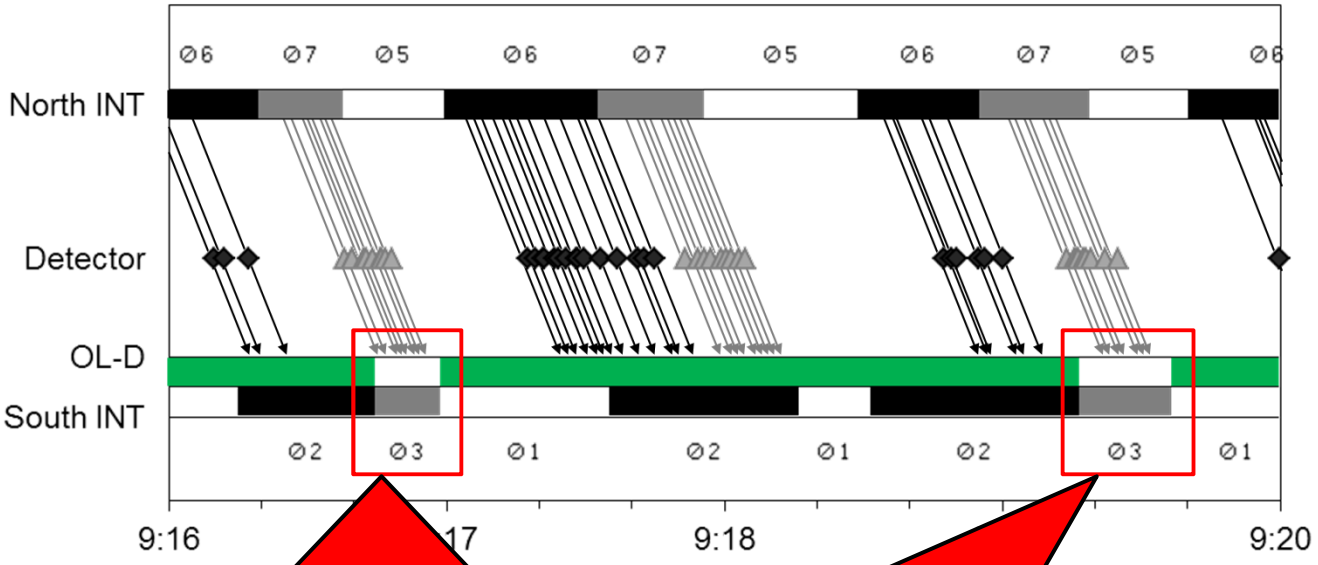
*Vehicles from upstream arrive later*

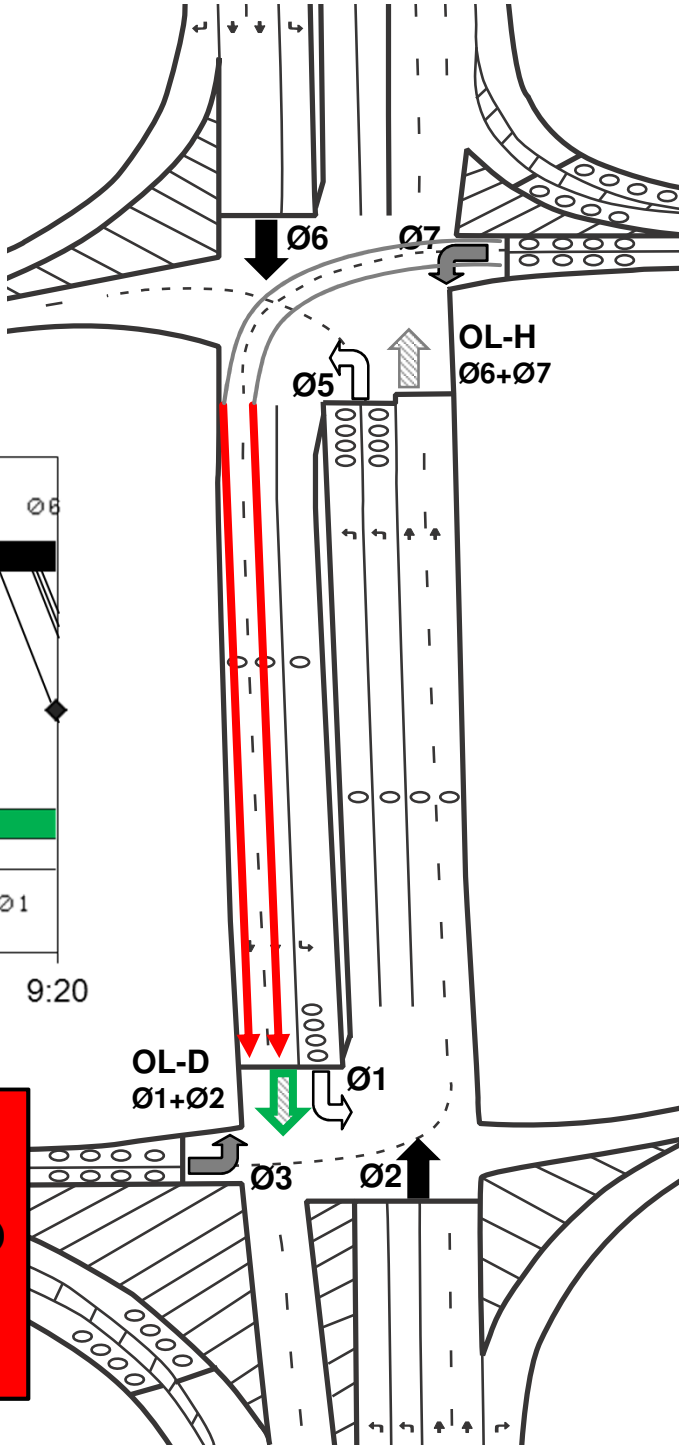


# Ring Displacement **+20 Seconds**

*Vehicles from upstream arrive later*



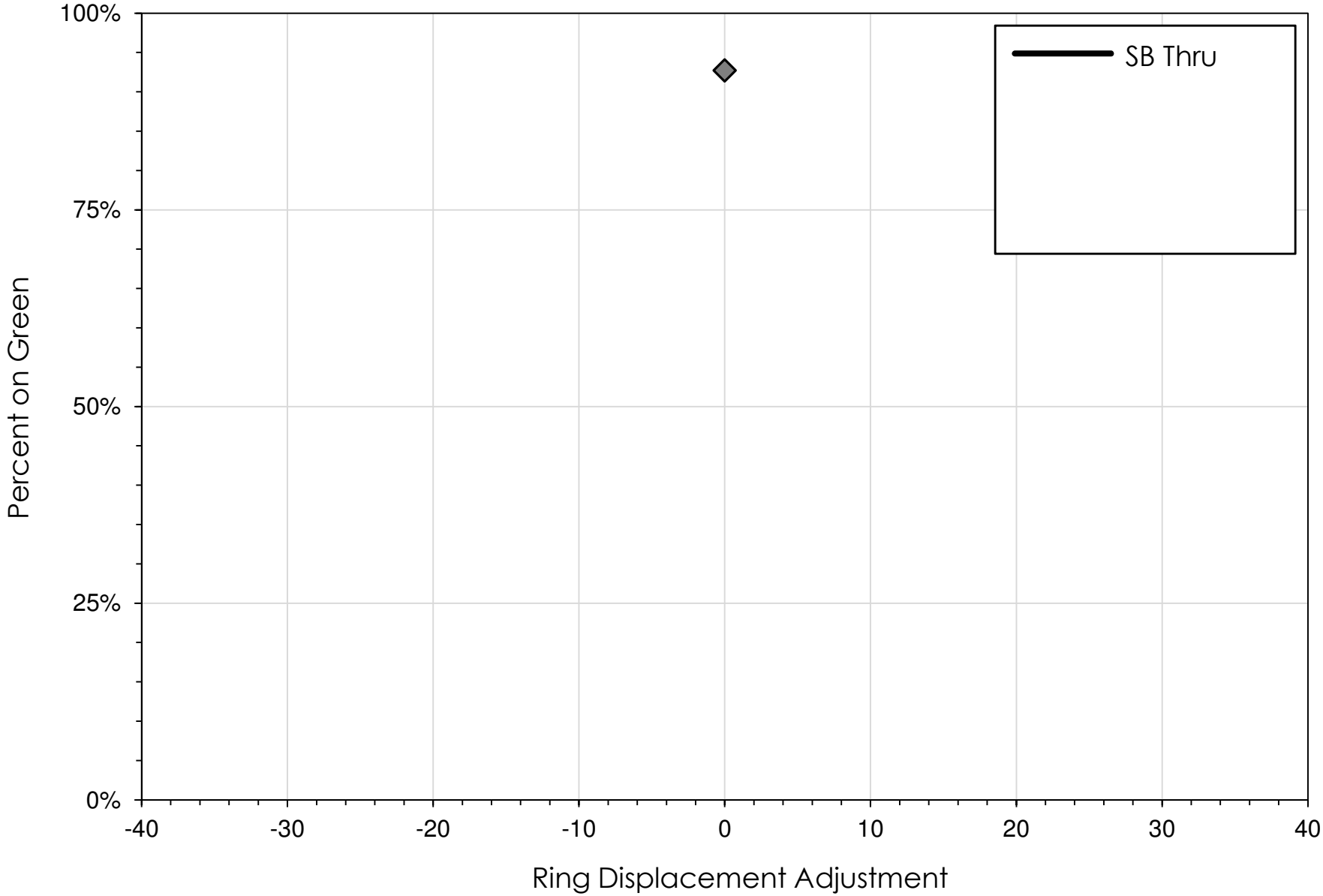




**By moving the ring displacement 20 seconds forward, the lagging WBL from the north ramp movement arrives at the south intersection on OL-D red while the EBL at the south ramp is served…**

**<u>Not Good</u>!**

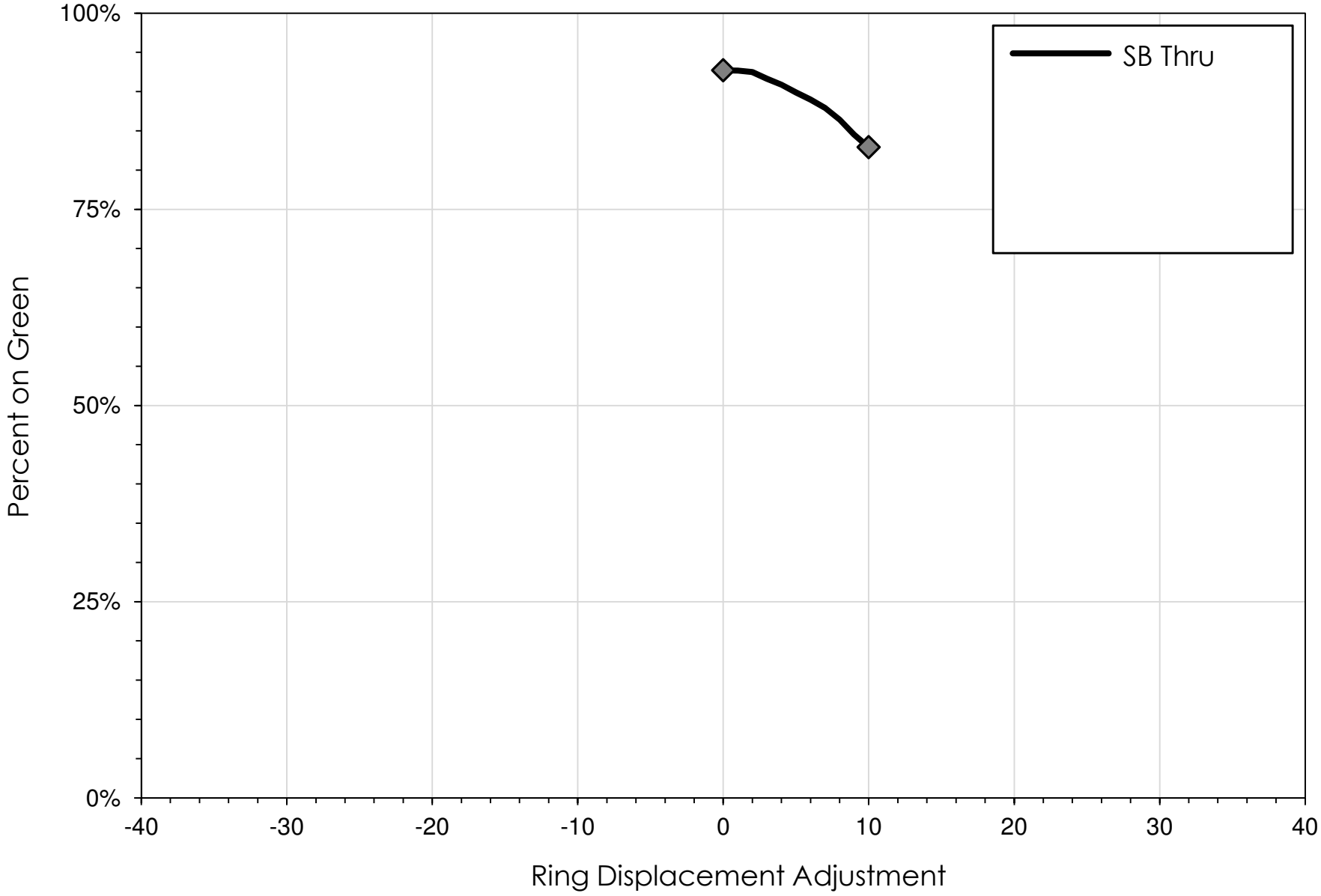
# Optimization Curves

*Let's Look at the Southbound Thru (Our +0, +10, +20 example)*



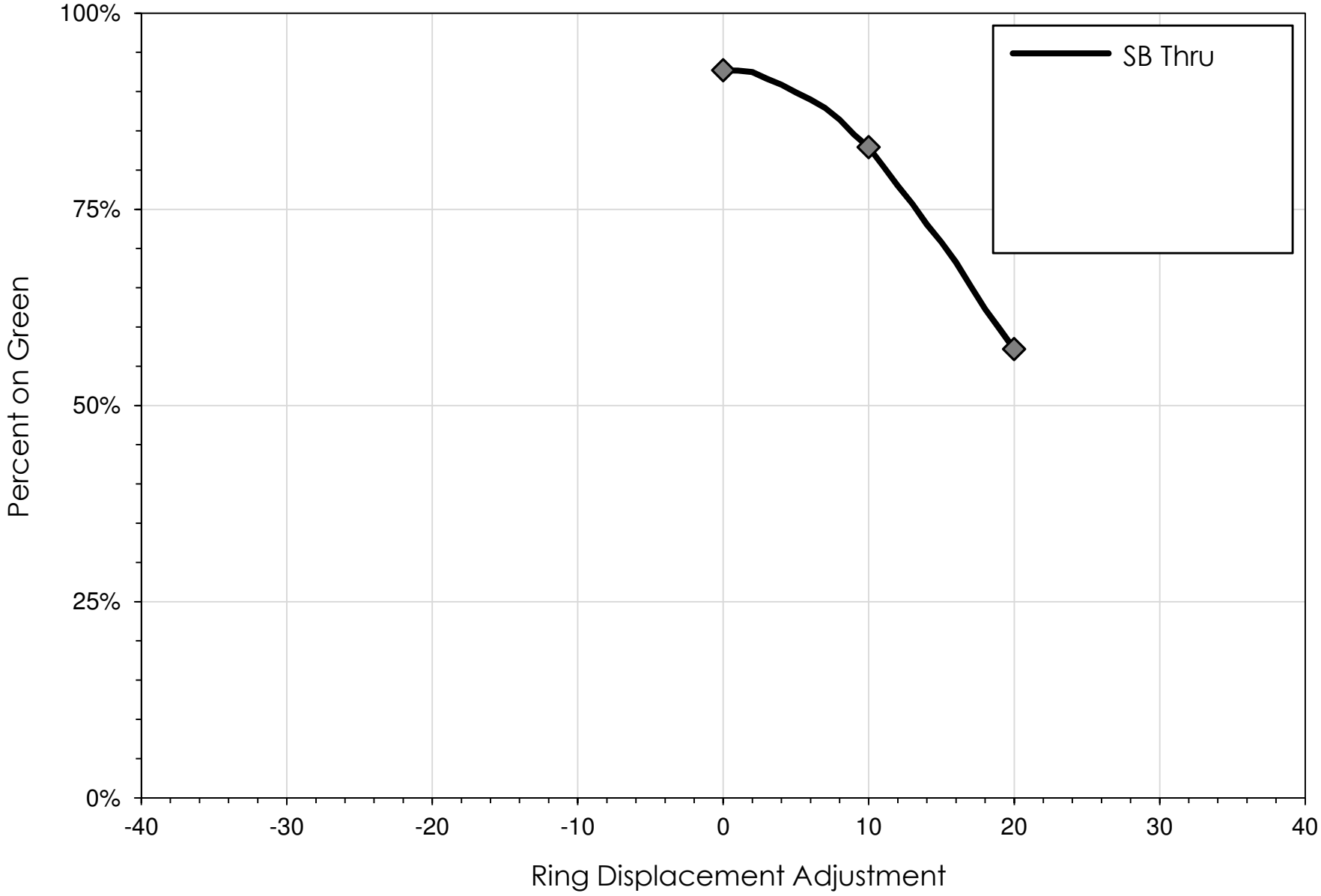
# Optimization Curves

*Southbound Thru +10*



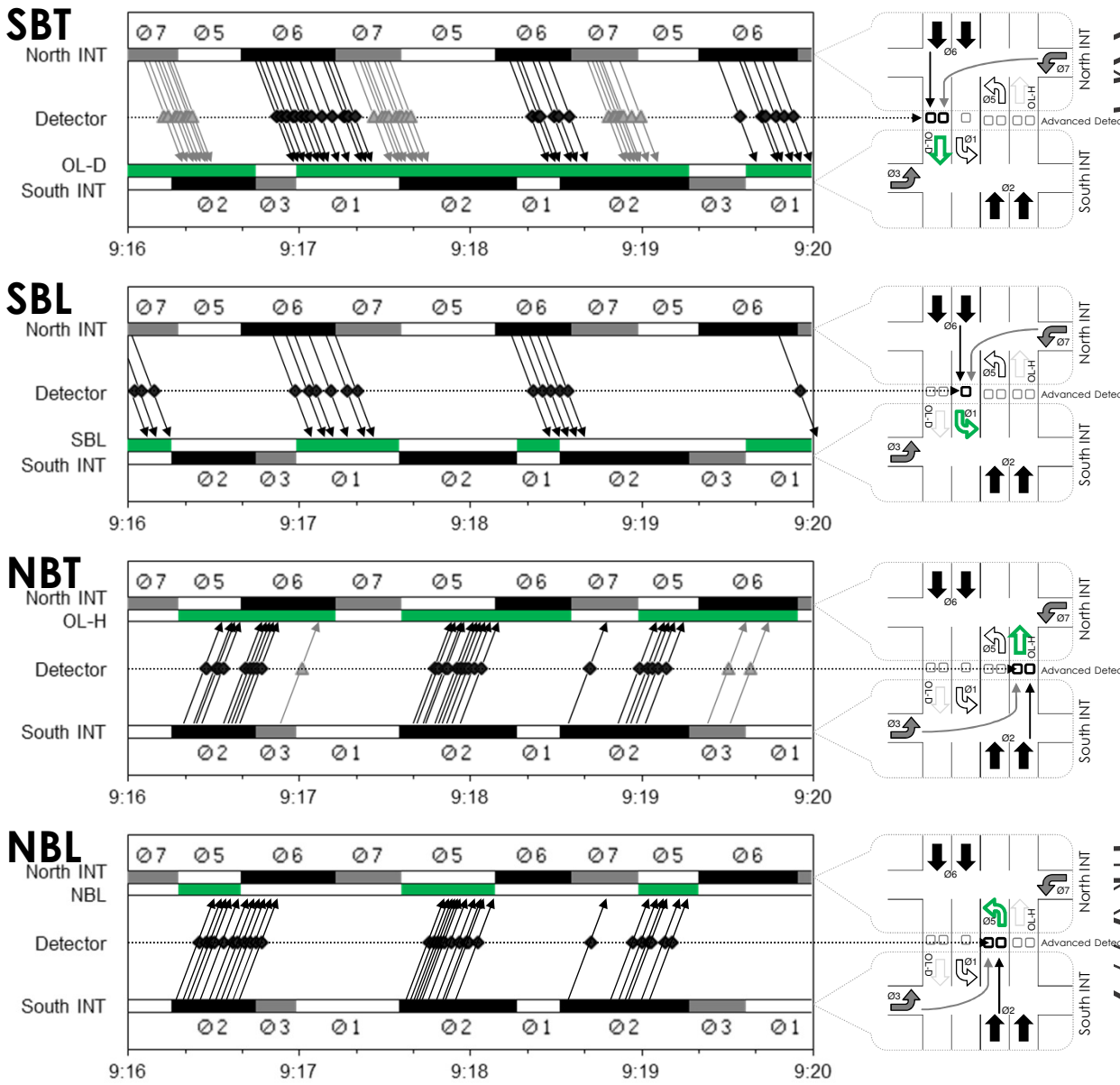
# Optimization Curves

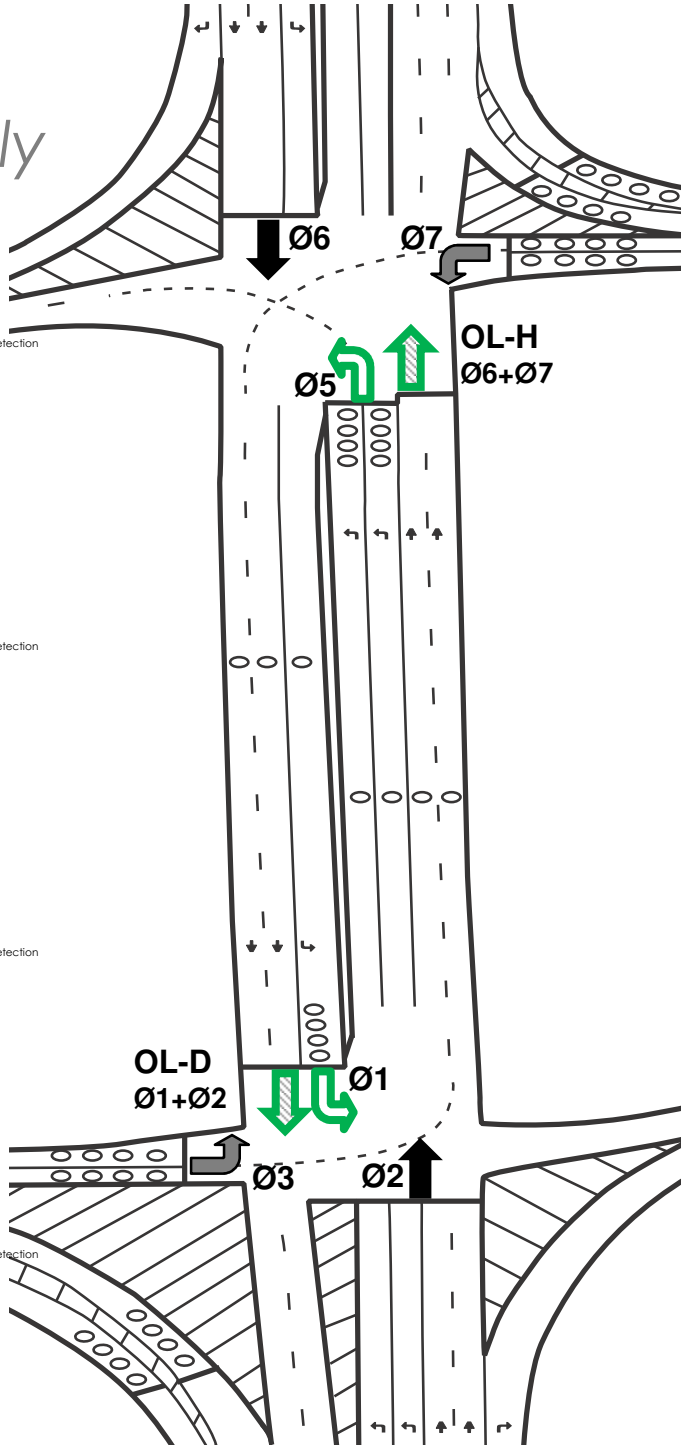
*Southbound Thru +20*



# Optimization Consideration

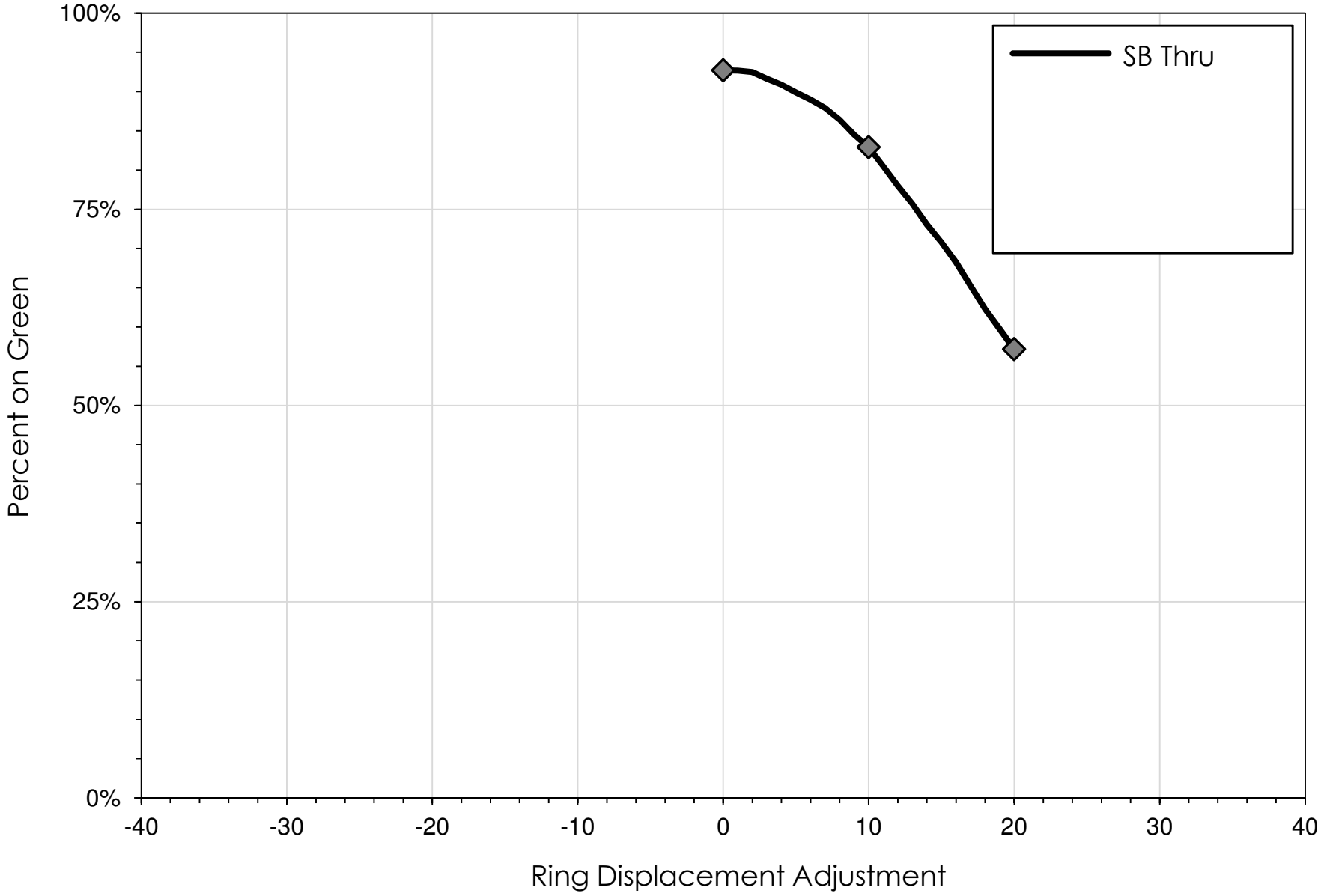
## *Consider All 4 Movements Simultaneously*



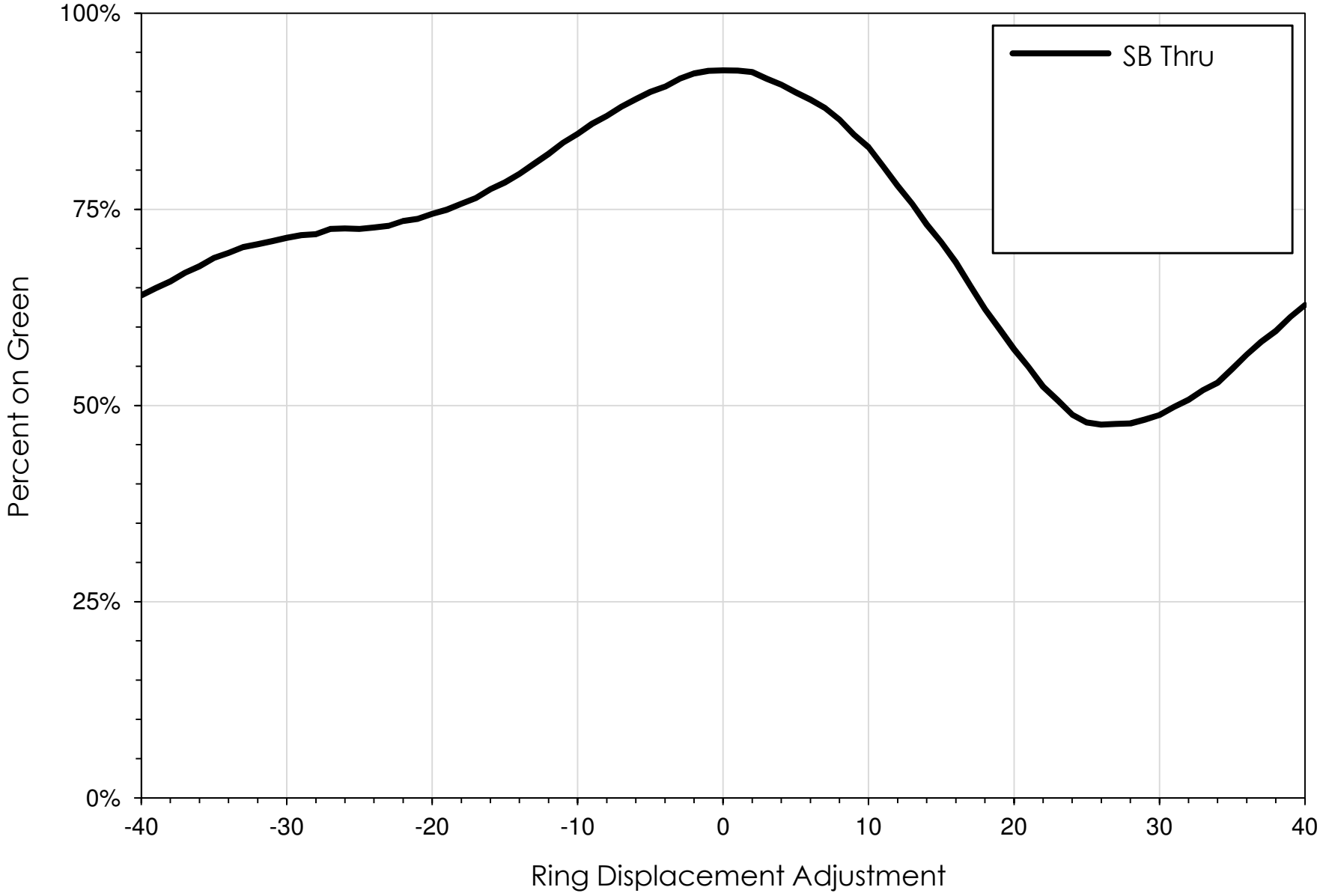
# Optimization Curves

*Southbound Thru +20*



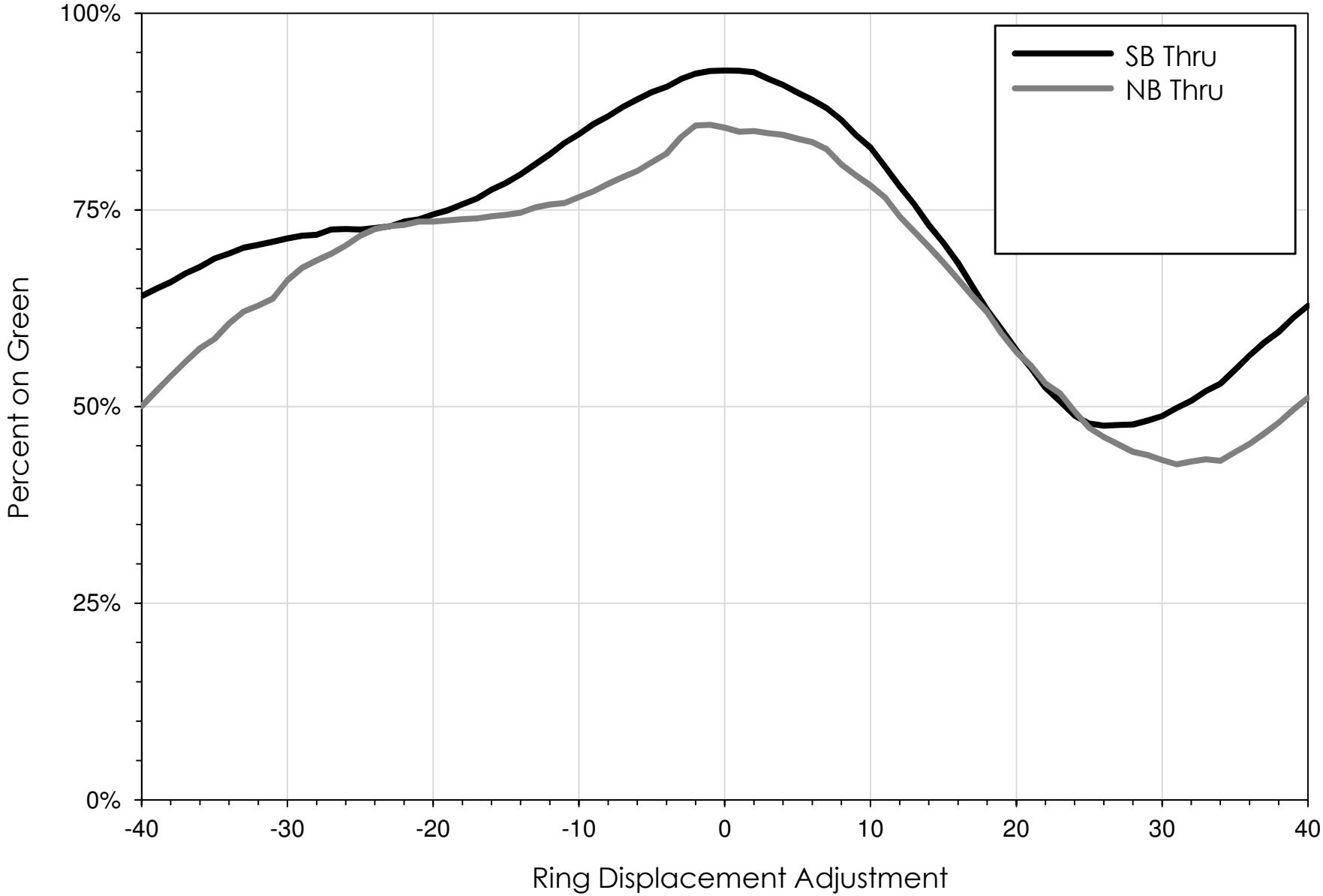
# Optimization Curves

*Southbound Thru for the Full Sweep*



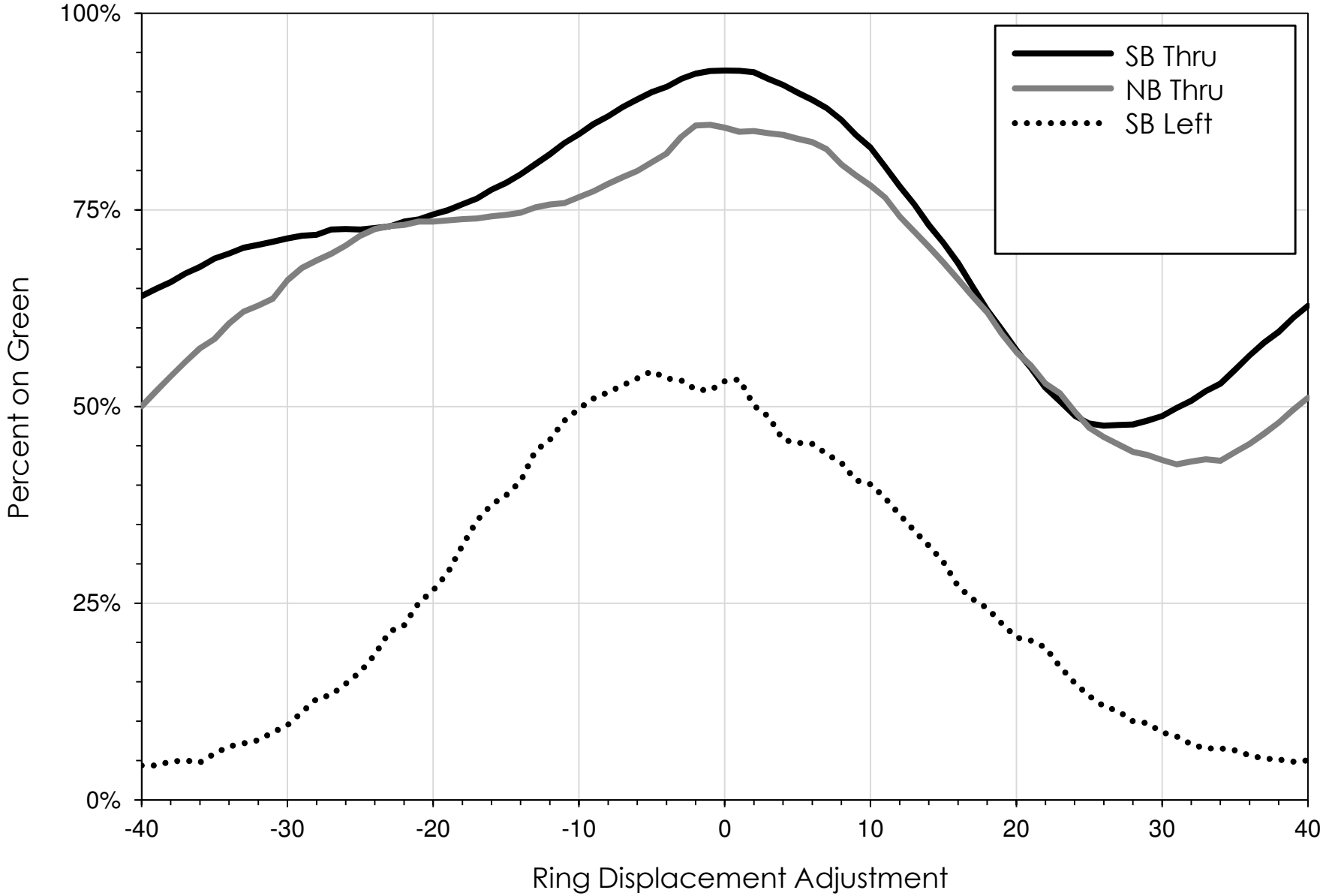
# Optimization Curves

*Northbound Thru*



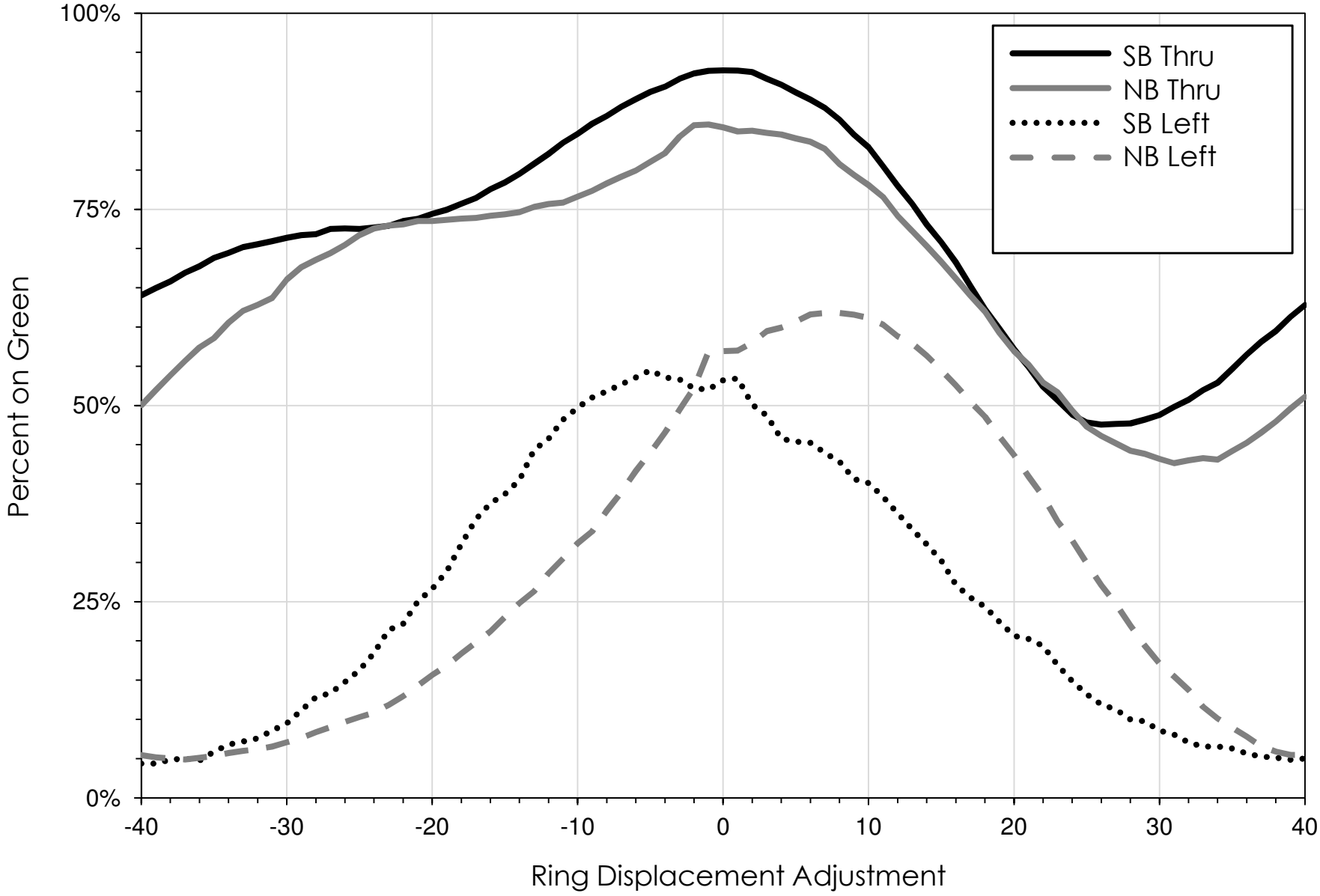
# Optimization Curves

*Southbound Left*



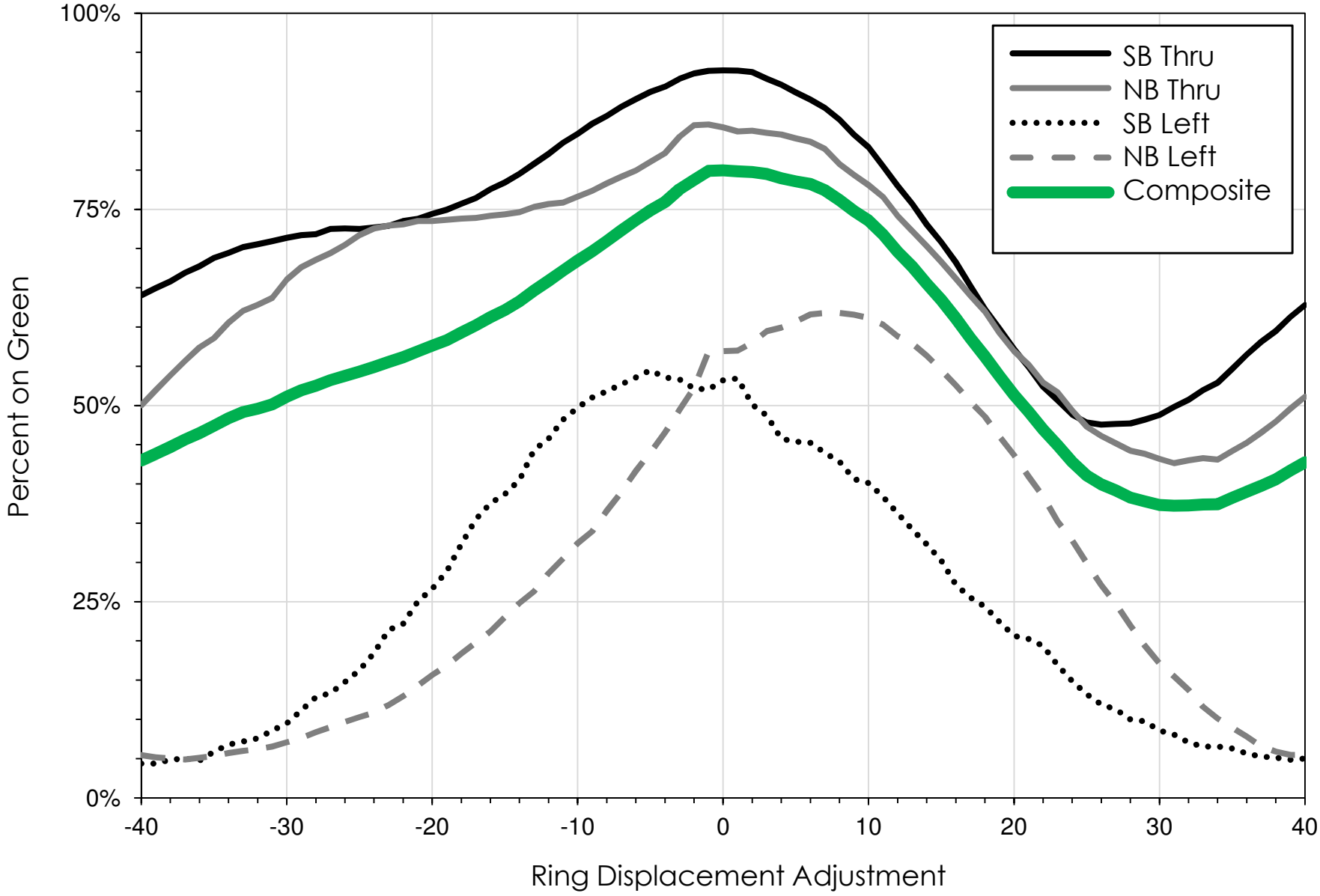
# Optimization Curves

*Northbound Left*



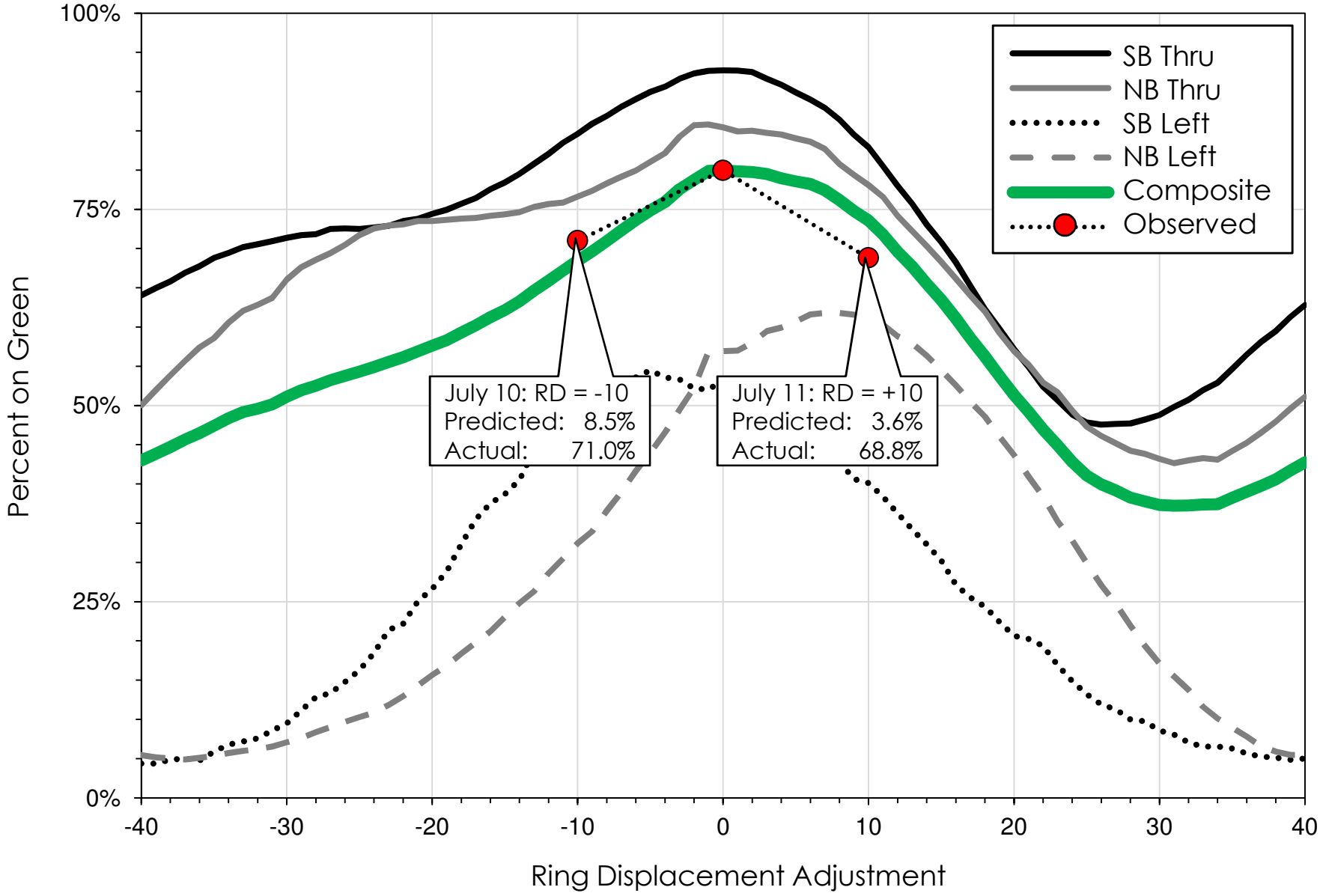
# Composite Interchange Sweep

*This is where all four movements are considered simultaneously*



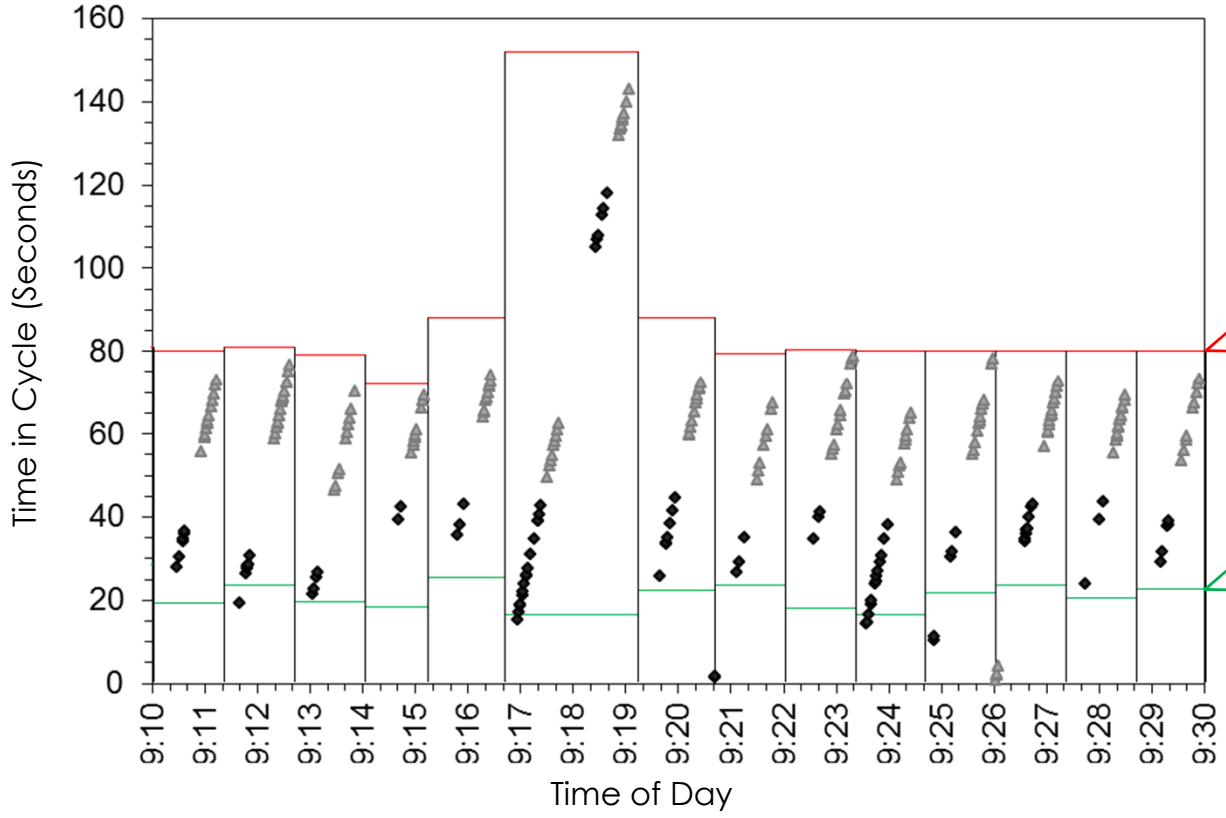
# Field Evaluation

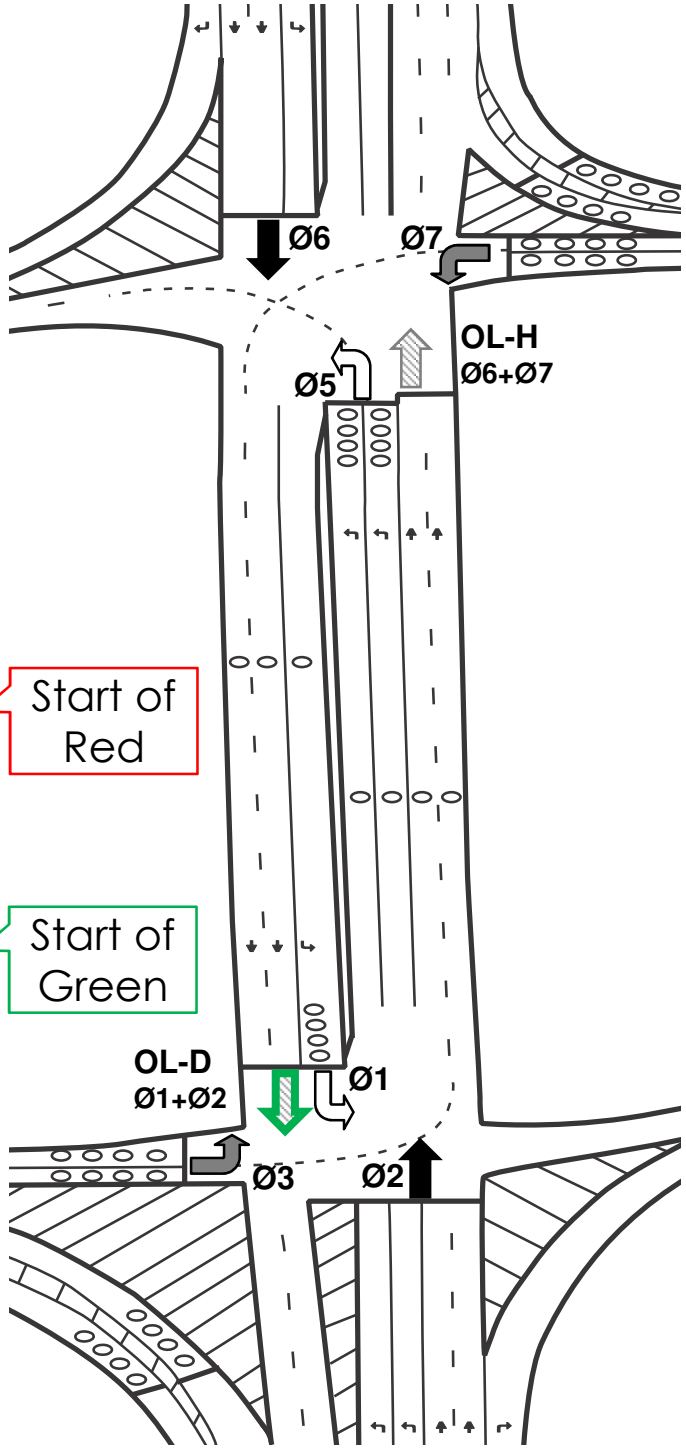
*Adjust +/- 10 to see how it worked in the field*



# Purdue Coordination Diagram

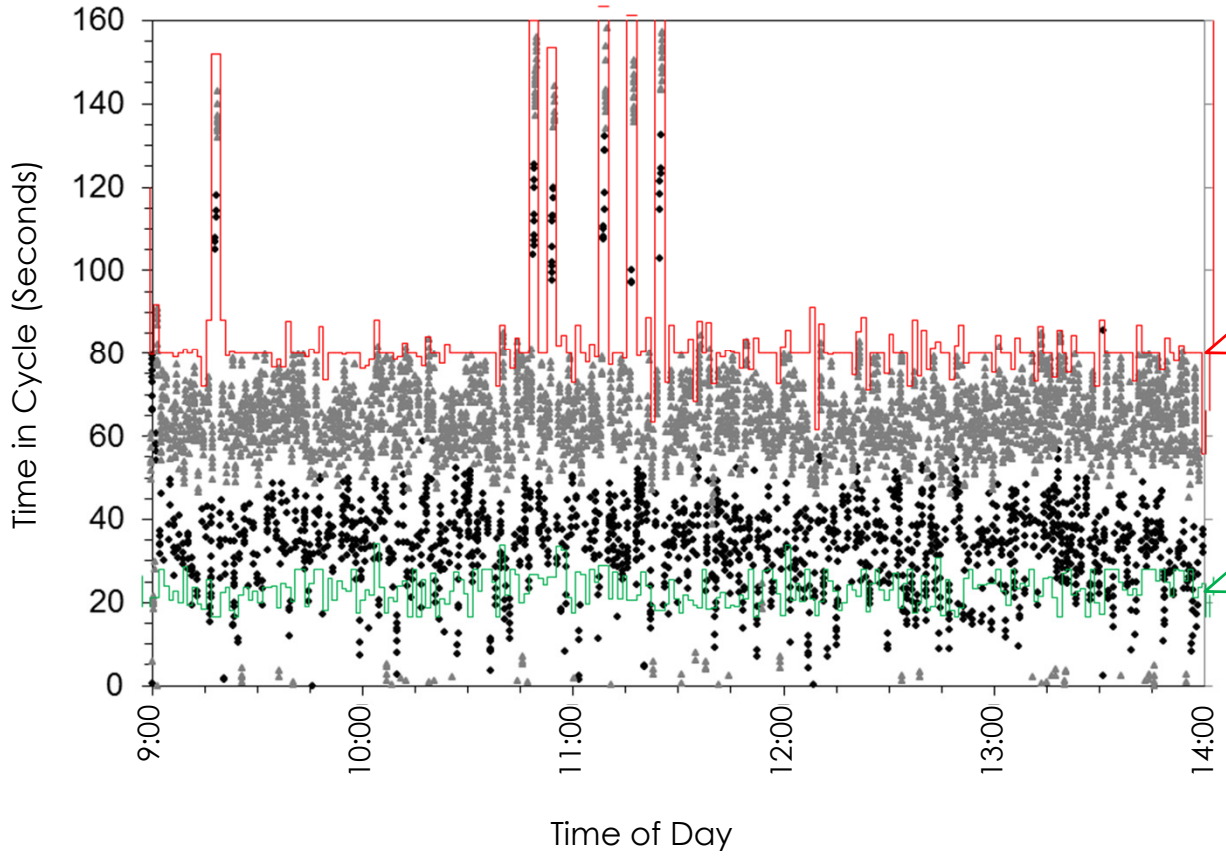
*Also Useful to Visualize Arrivals on Green*

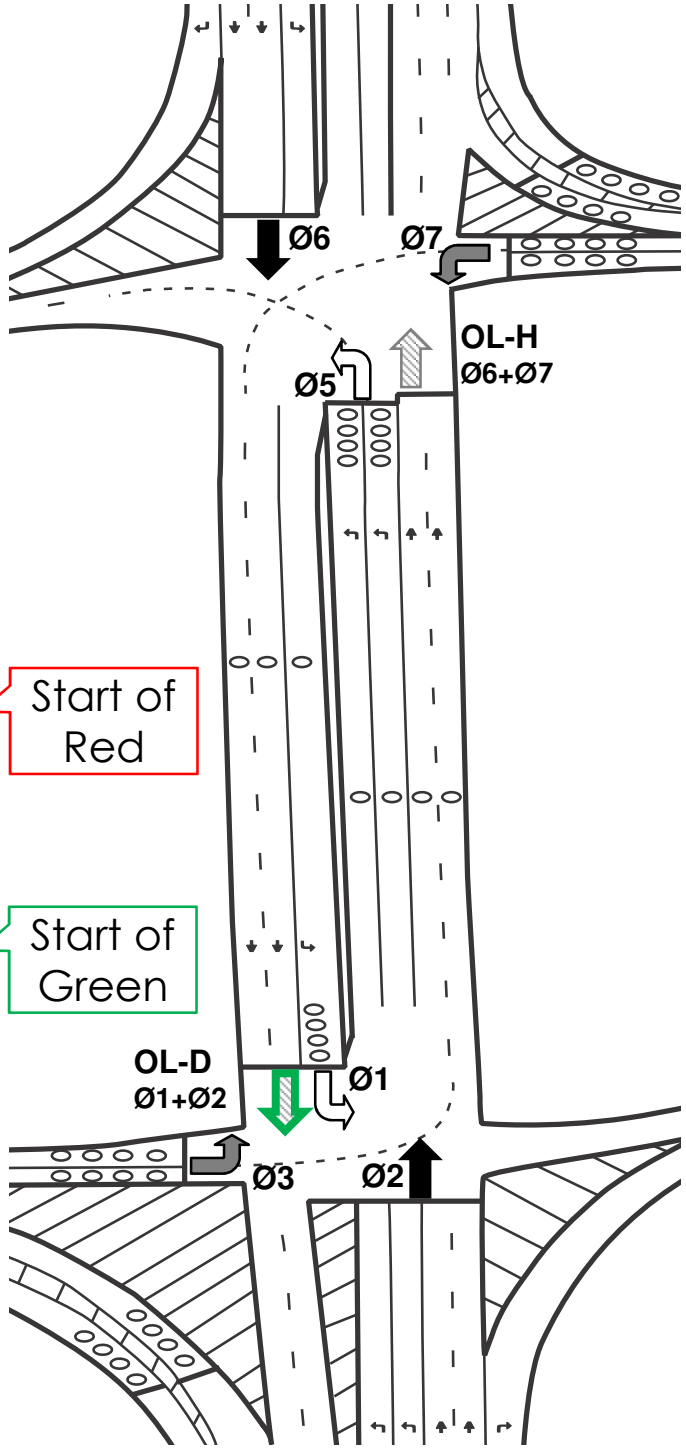


# Purdue Coordination Diagram

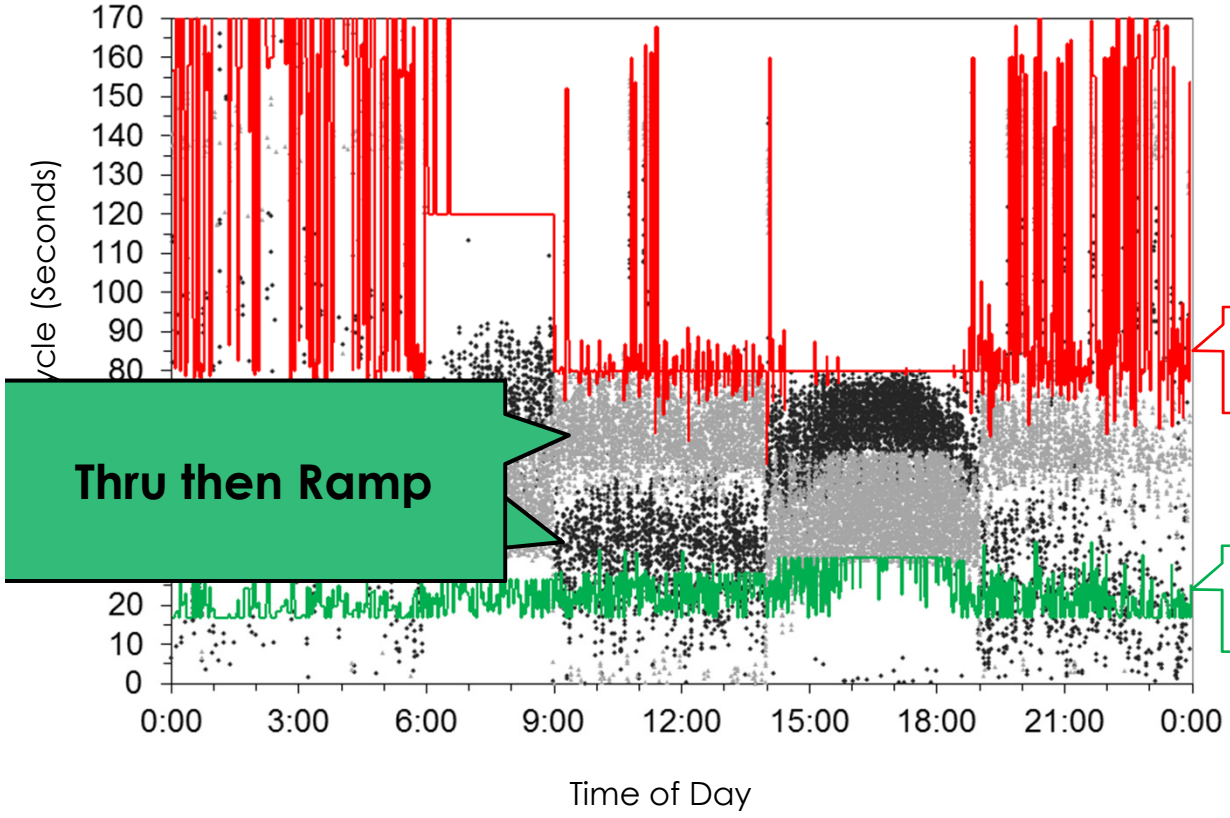
*Looking at an entire plan (0900-1400)*

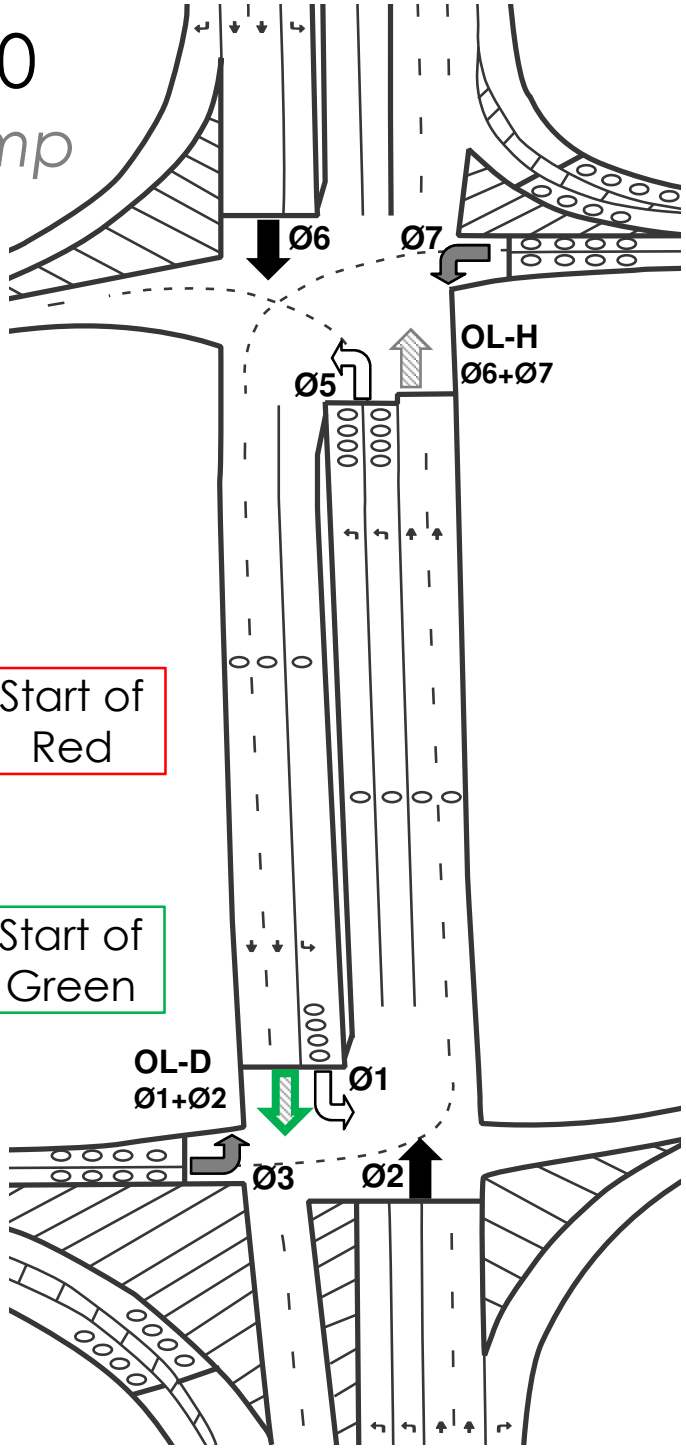


# 24HR PCD: Sequence for 0900-1400

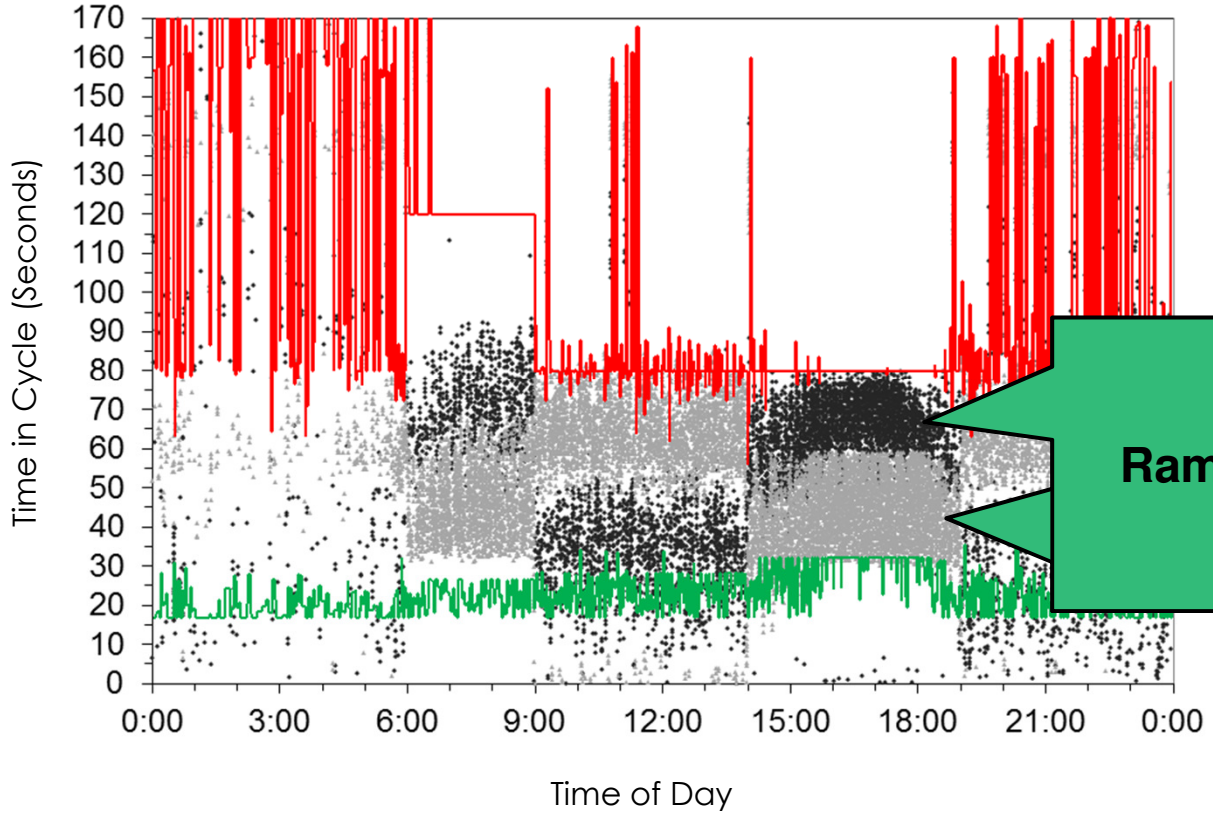
*First is Ø6 SBT, then Ø7 WBL from the ramp*



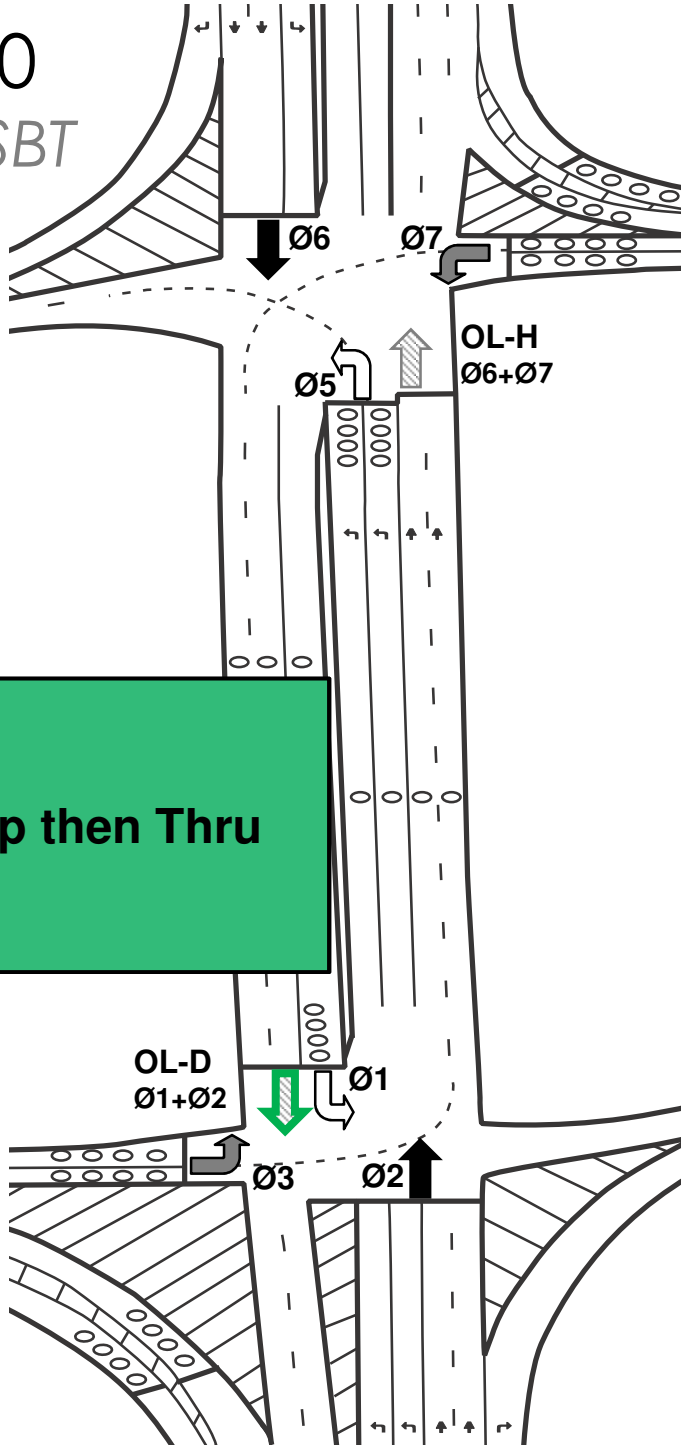



# 24HR PCD: Sequence for 1400-1900

*First is Ø7 WBL from the ramp, then Ø6 SBT*




**Ramp then Thru**

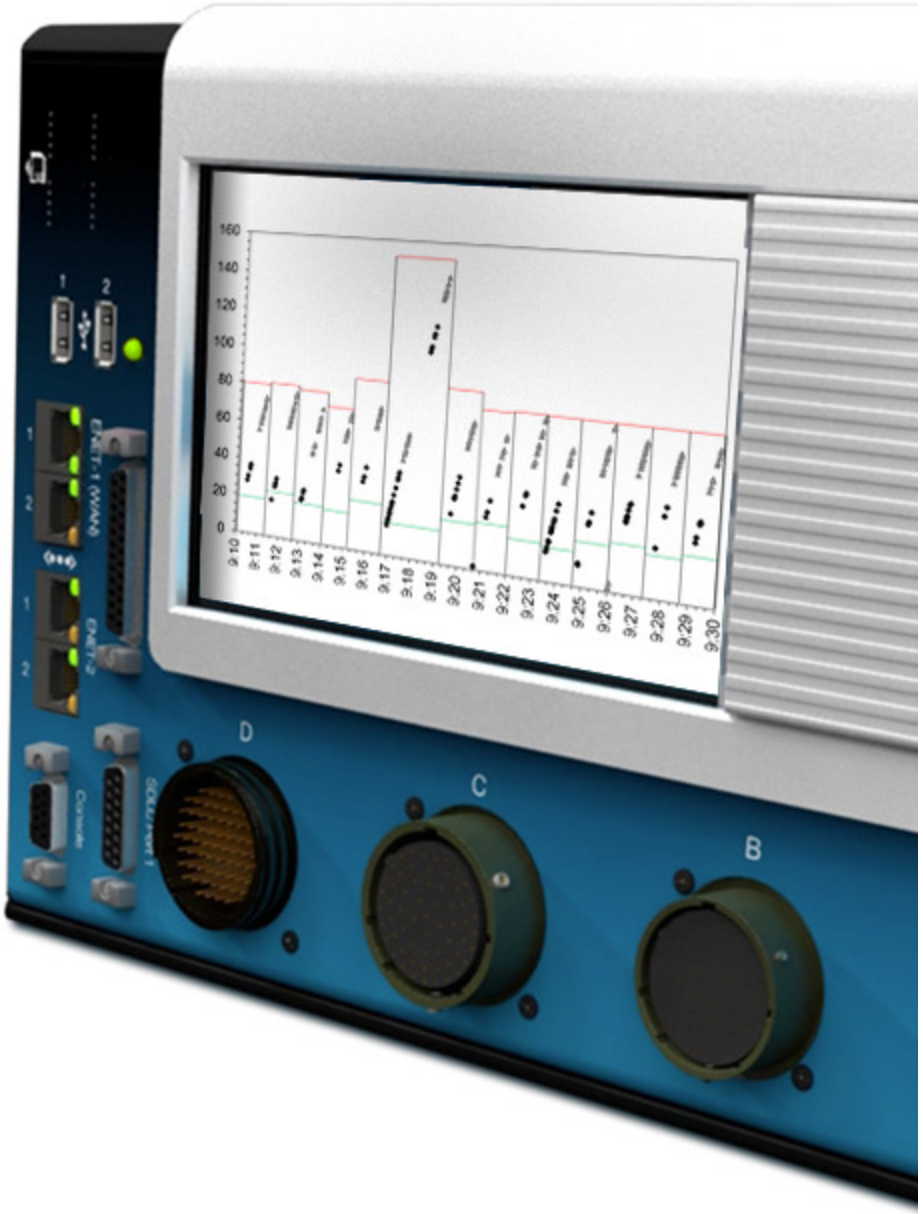


# Conclusion: These Graphics are Useful!

*Can they be included on newer generation traffic controllers?*


# Conclusion: These Graphics are Useful!

*Can they be included on newer generation traffic controllers?*

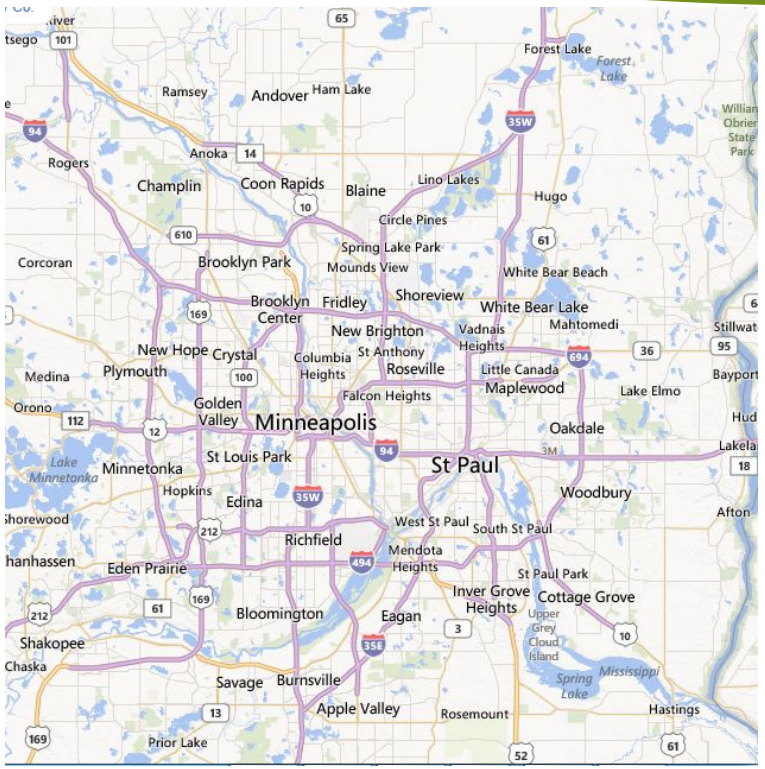



# AUTOMATED TRAFFIC SIGNAL PERFORMANCE MEASURES CASE STUDIES: MnDOT

**INSTITUTE OF TRANSPORTATION ENGINEERS WEBINAR PART 1 – MAY 7, 2014**

PRESENTED BY STEVE MISGEN, MNDOT

# MnDOT - Metro District Background




- Operates about 700 signals (Mpls/St. Paul Metro area)
  - 250 signal on i2 central system
  - 450 on ARIES dial-up
- Econolite ASC2/ASC2S or ASC3 controllers
- Signal Performance Measure
  - 83 on Smart Signal
  - 21 on Utah SPM

# Smart Signal

- University of Minnesota
  - Henry Liu
- Minnesota Department of Transportation
- http://dotapp7.dot.state.mn.us
  - iMonitor – "Real-time" Level of Service
  - iMeasure – Data extraction tool

# Smart Signal

iMonitor™ / iMeasure™

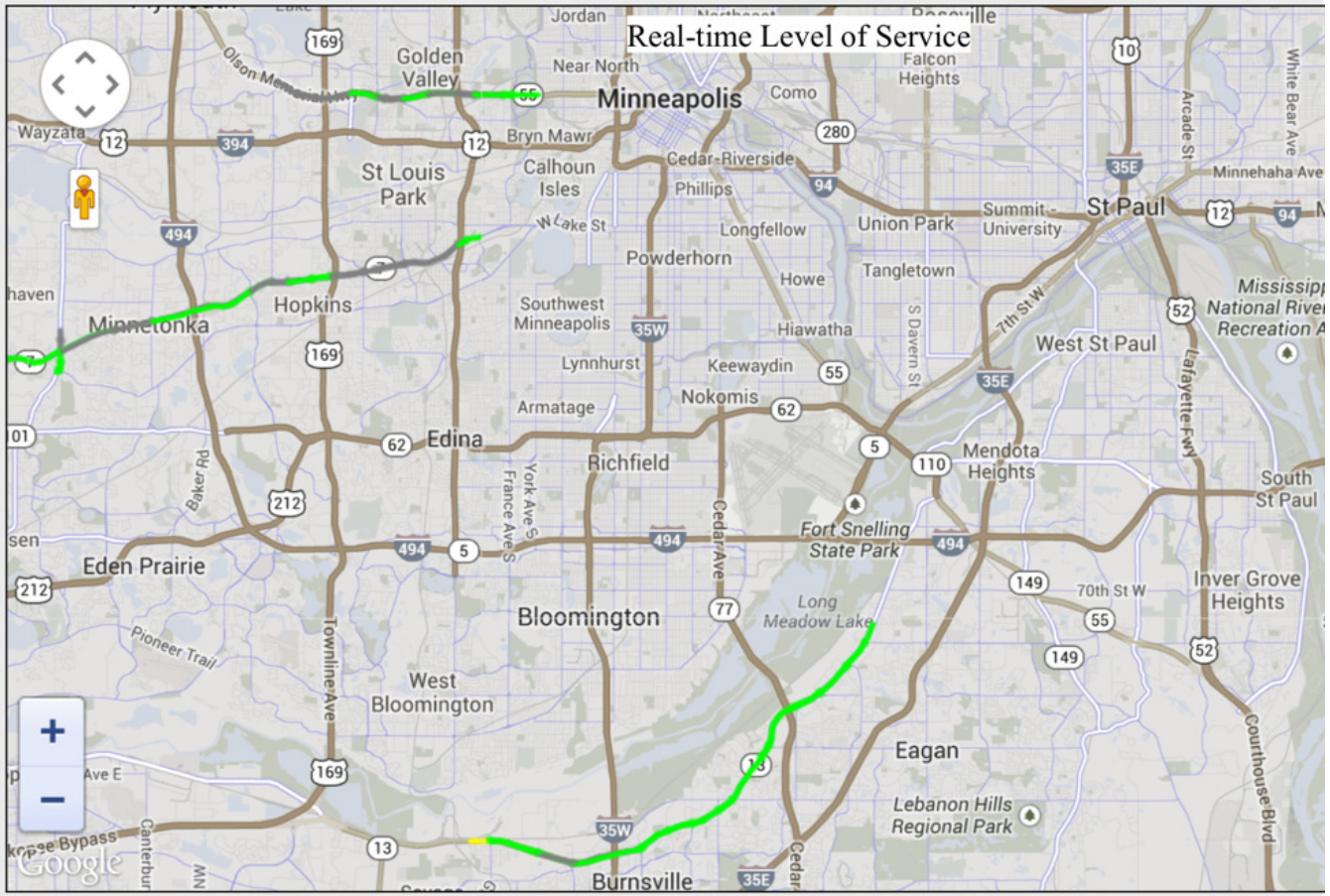
- System Overview
- System Check
- Site Access
- Help

LOS Legend:

- A&B
- C&D
- E
- F
- Real time data not available

Link Delay Legend:

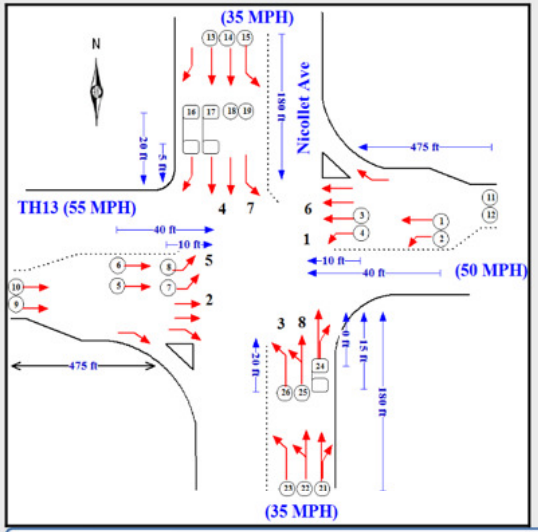
- < 20 Sec./Veh.
- Between 20 and 55 Sec./Veh
- Between 55 and 80 Sec./Veh.
- >80 Sec./Veh.
- Real time data not available



# Smart Signal

- Performance Assessment
- Optimization Preparation
- Fine-tuning Analysis
- Performance Comparison
- Retiming Benefits
- Periodic Report
- Help

## Volume Output



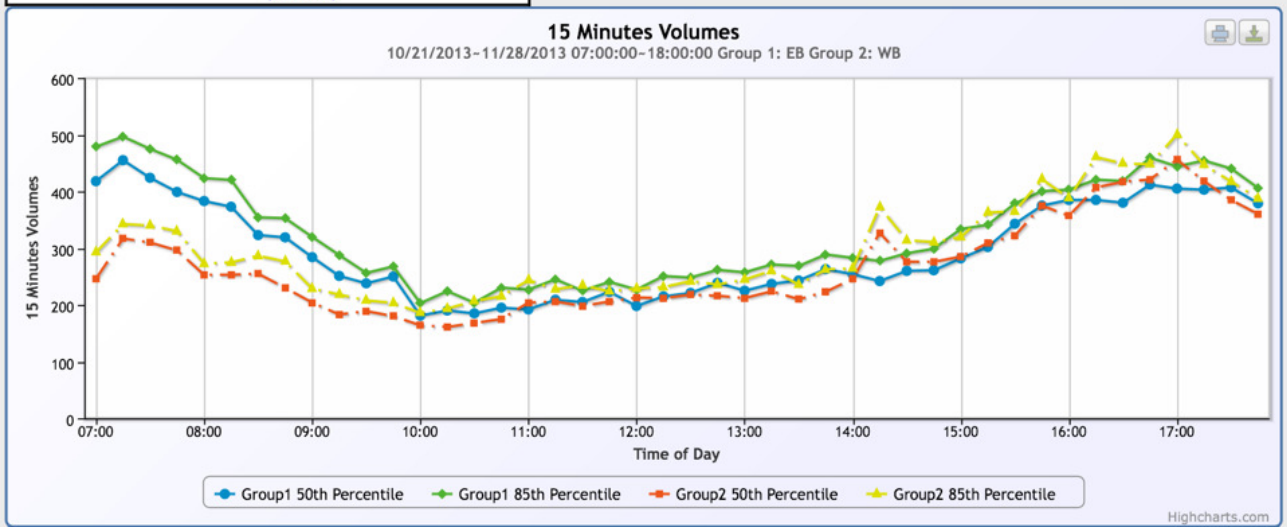

Intersection: TH13/Nicollet  Approach Selection Mode: Normal / Expert

Approaches (Group 1): Select  Approaches (Group 2): Select

Start Date: 10/21/2013  End Date: 11/28/2013  Day of Week: Select Days

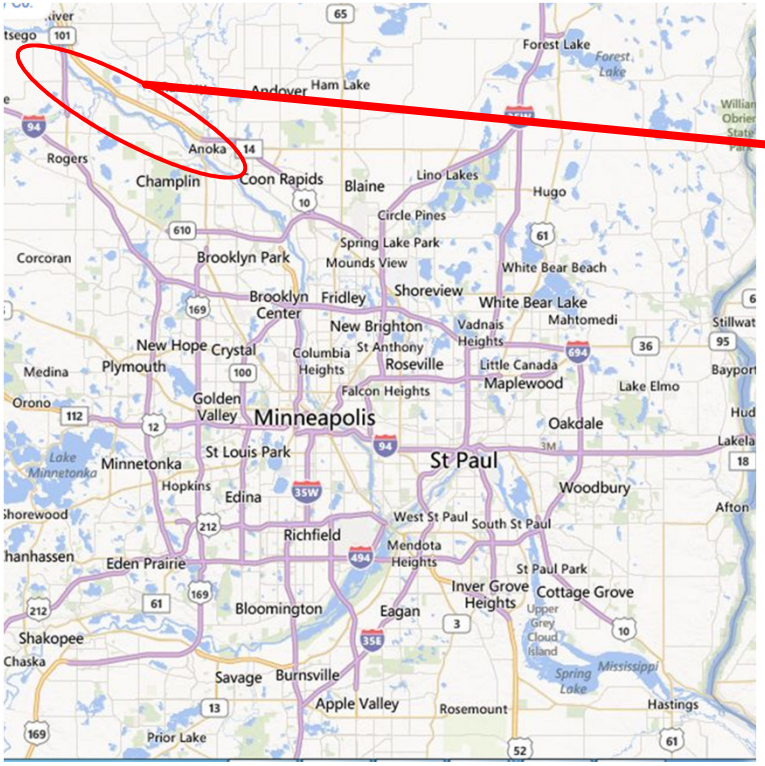
Start Time: 07:00:00  End Time: 18:00:00  Interval: 15 Minutes

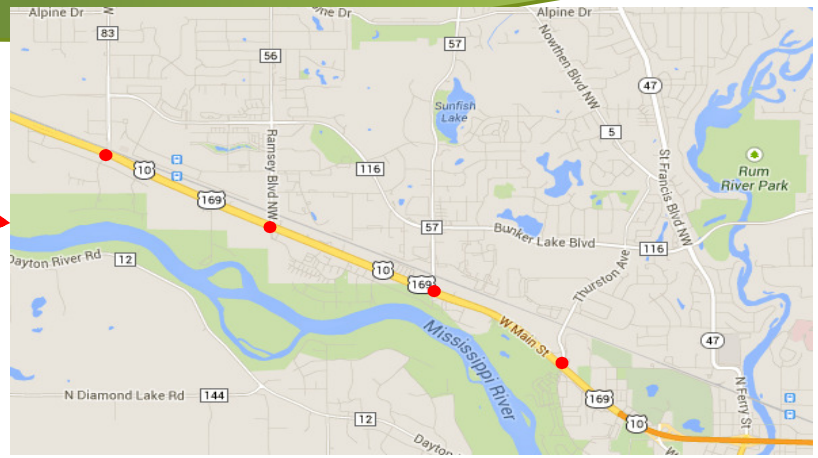
Plot  Save Data



# The Project

## Develop New Timing Using High Resolution Data collected from SmartSignal




- 4 fully-actuated signals
- High speed 60-65 mph posted
- 33,000-68,000 AADT
- 7 TOD plans
- Last retimed 2009

# Signal Timing Development

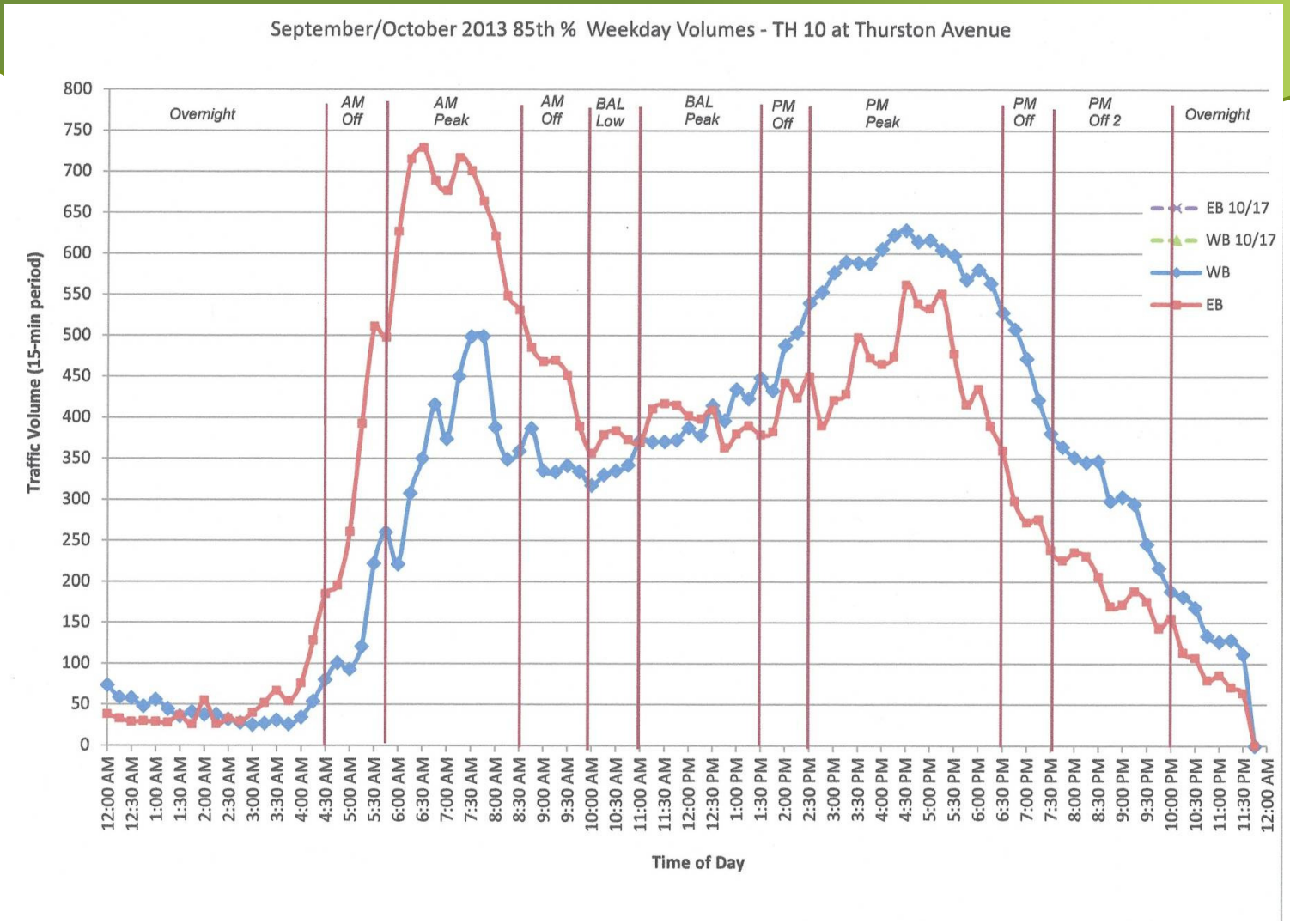
Standard Method

- Data Collection
  - Manual Turning Movement Count – 12 hour
  - System Detectors
- Synchro – approximation of splits & cycle lengths
- Implementation & fine turning completed by time space diagram and field observations
- Before/After Comparison using Travel Time Studies

Improved Method

- Data Collection
  - Automated collection averaged over Sept-Oct for each movement (M-Th, F, S & S)
- Synchro - Time-space diagram for best two-way progression
- Implementation & fine turning completed by time-space diagram and field observations
- Smart Signal – monitor and make adjustments to insure efficiency
- Before/After Comparison using signal performance metrics

# Volumes


September/October 2013 85th % Weekday Volumes - TH 10 at Thurston Avenue
Overnight
AM Off
AM Peak
AM Off
BAL Low
BAL Peak
PM Off
PM Peak
PM Off
PM Off 2
Overnight
EB 10/17
WB 10/17
WB
EB
Traffic Volume (15-min period)
Time of Day

# Before/After Performance Comparison

| Performance Comparison - Peak Hours (Total Intersection) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **TH 10 at Sunfish Blvd** | Volume (# of vehicles) | | Total Delay (Hours) | | Number of Stops | | Maximum Queue (Feet) | | Saturation Level | | % of Vehicles Arriving On Green | |
| | Total Intersection | | Total Intersection | | Total Intersection | | Total Intersection | | Total Intersection | | Total Intersection | |
| **Time of Day** | Before[1] | After[2] | Before[1] | After[2] | Before[1] | After[2] | Before[1] | After[2] | Before[1] | After[2] | Before[1] | After[2] |
| **AM Peak Hour 7:00 am to 8:00 am** | 3426 | 2906 | 30.15 | 21.9 | 2545 | 1484 | 613 | 121 | 0.74 | 0.54 | 0.7 | 0.84 |
| **Mid-Day Peak Hour 1:30 pm to 2:30 pm** | 2882 | 1982 | 14.42 | 11.27 | 1281 | 773 | 226 | 68 | 0.64 | 0.38 | 0.68 | 0.9 |
| **PM Peak Hour 4:30 pm to 5:30 pm** | 4082 | 2844 | 28.98 | 17.81 | 2352 | 1040 | 589 | 99 | 0.92 | 0.53 | 0.74 | 0.87 |
| **Total 5:00 am to 10:00 pm** | 46065 | 33607 | 256.41 | 177.01 | 21340 | 11301 | 261 | 58 | 0.63 | 0.34 | 0.6 | 0.9 |

# Future Plans

- Performance Index
  - based on volume, delay, number of stops, max queue length, saturation level & percent of vehicles arriving on Green
  - Calculate the PI for a given period on time (PM Peak) over a period of time (every Wednesday for the past year)
  - Track the change on performance over time
    - **When do you need to retime!**
- Time-space Diagram
  - Real-time TSD based on detector actuations
- Performance Metrics
  - Emissions – $CO_2$ fuel consumed

# Future Plans
## Performance Index Over Time

# MnDOT Signal Performance Measures

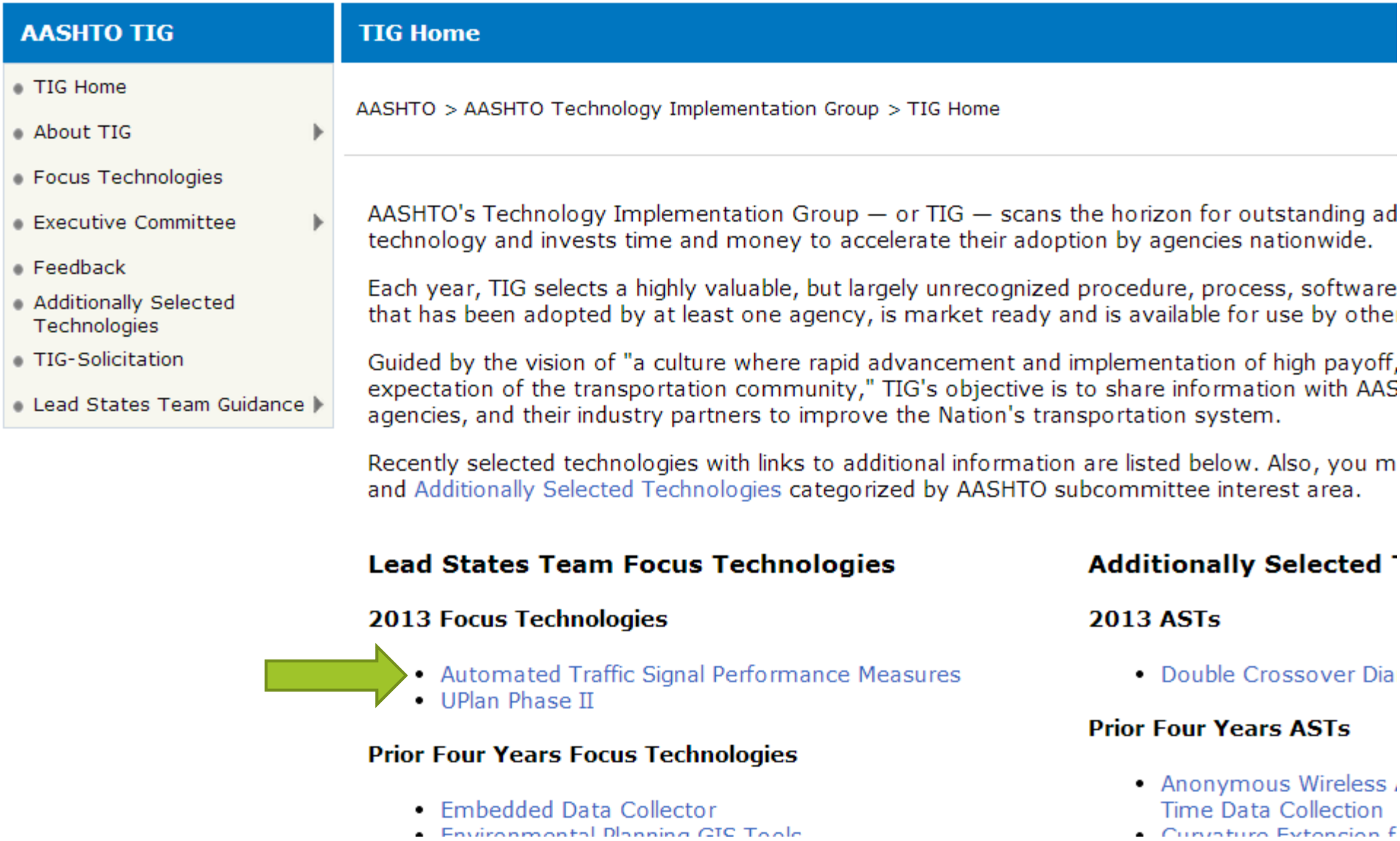
Steve Misgen, PE, PTOE

MnDOT – Metro District

Traffic Engineer

Steve.misgen@state.mn.us

# Find out more: http://tig.transportation.org



# ITE Webinar Series on Automated Traffic Signal Performance Measures (SPMs)

- Achieve Your Agency's Objectives Using SPMs

  April 9, 2014, 12:00 pm to 1:30 pm. Eastern

- SPM Case Studies

  May 7, 2014, 12:00 pm to 1:30 pm. Eastern

- Critical Infrastructure Elements for SPMs

  June 11, 2014, 12:00 pm to 1:30 pm. Eastern

Jamie Mackey

UDOT

Amanda Stevens

INDOT

Alex Hainen

Purdue

Steve Misgen

MnDOT

# Thank you.

## QUESTIONS?

**http://tig.transportation.org**

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